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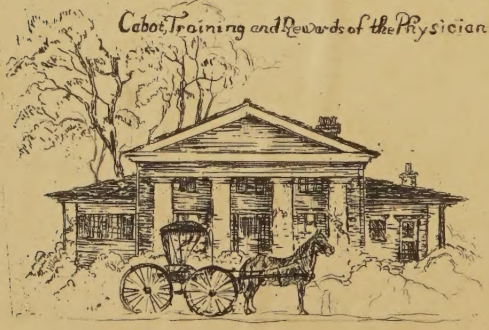

TABLES

FOR THE

DETERMINATION OF MINERALS

Books by

EDWARD H. KRAUS

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638 pages, 6×9, 812 Illustrations

TABLES

FOR THE

DETERMINATION OF MINERALS

BY MEANS OF

THEIR PHYSICAL PROPERTIES, OCCURRENCES, AND ASSOCIATES

BY

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SECOND EDITION
THIRD IMPRESSION

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PREFACE TO THE SECOND EDITION

These tables have been used with marked success for nearly two decades. This clearly demonstrates that their arrangement is not only sound in principle but also practical in application.

In this revision the tables remain essentially unchanged. A few minerals have, however, been added and in several instances varieties of minerals already in the tables have been incorporated under other colors. References to descriptions of minerals in various texts have been omitted.

The Introduction has been enlarged by the addition of several physical properties not included in the first edition. Following the determinative tables there has been added a table in which the minerals are arranged according to specific gravity. This table should prove to be helpful.

MINERALOGICAL LABORATORY,
UNIVERSITY OF MICHIGAN,
August, 1930.

E. H. K.
W. F. H.

PREFACE TO THE FIRST EDITION

The successful determination of minerals at sight depends upon the ability to make quick and accurate distinctions between the physical properties, occurrences, and associates of the several minerals which may be suggested by the luster, color, form, streak, and hardness, especially, of a given specimen. As a result of extensive experience in the laboratory and field, luster and color have been made the fundamental basis of these tables, further subdivisions being introduced by the streak and hardness. Minerals with similar physical properties are thus grouped together, aiding the student materially to acquire the necessary facility to make rapid distinctions.

The tables include 250 of the most common minerals, classified into three groups, which may be designated as (1) very common, (2) common, and (3) not common, but important. The display given to the name of a mineral indicates at a glance in which of the above groups it has been placed. Page references to several textbooks on mineralogy will be found of great convenience when more detailed descriptions are desired than obviously can be given in determinative tables.

We have drawn freely upon all possible sources but are under especial obligations to Weisbach, Klockmann, Crosby, and Eakle, whose tables were constantly before us.

Mineralogical Laboratory,
University of Michigan,
February, 1911.

Edward H. Kraus.
Walter F. Hunt.

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TABLES FOR THE DETERMINATION OF MINERALS

INTRODUCTION

PHYSICAL PROPERTIES

The physical properties of most importance in the determination of minerals at sight, that is without the aid of blowpipe or chemical reactions or the mineralogical microscope, will be described briefly. All terms given in the introduction or used in describing minerals in the tables are defined in the glossary, page 11.

Luster.—The luster of a mineral is the appearance of its surface in reflected light, and is a property of fundamental importance in the rapid determination of minerals. The luster and color of minerals may usually be easily recognized at first sight.

Lusters may be divided into two large groups: *metallic* and *non-metallic*. The metallic luster is indicative of metals and is exhibited by minerals which are opaque or nearly so. They are also generally quite heavy. All other lusters may be designated as non-metallic, some of the more important being:

Vitreous.—The luster of glass or quartz.

Adamantine.—The exceedingly brilliant luster of minerals with high indices of refraction, as the diamond and pyromorphite.

Resinous.—The luster or appearance of resin. This is well shown by sphalerite.

Greasy.—The appearance of an oiled surface. Example, nephelite.

Pearly.—This is similar to the luster of the mother of pearl. It is commonly shown by minerals with a lamellar or platy structure, and by those with pronounced cleavages. Example, talc.

Silky.—This luster is the result of a fibrous structure and is well shown by fibrous gypsum (satin spar) and asbestos.

Dull.—Not bright or shiny, good examples being chalk and kaolin. Sometimes called *earthy* luster.

The terms *splendent, shining, glistening,* and *glimmering* are sometimes used. They have reference to the intensity or quantity of light reflected.

In some instances the luster is not the same on all faces of a crystal. Thus, on apophyllite it is pearly on the basal pinacoid and vitreous elsewhere.

When a luster is intermediate between metallic and non-metallic it is frequently called *submetallic*.

Color.—The color of a mineral is one of the first physical properties to be observed. Some minerals have a fairly constant color while others occur in a great variety of colors. Minerals which are always of the same general color are called *idiochromatic*. Thus, sulphur is always yellow, while malachite is green. For such minerals the color is of importance in their recognition. In other minerals the color may vary greatly, due to the presence of pigments, inclusions, or other impurities. Such minerals are termed *allochromatic*. Good examples are calcite and quartz, both of which show a great variety of colors. The terms used in describing the various colors need no explanation.

Streak.—This is the color of the fine powder of a mineral and is frequently made use of in the determination of minerals. Although the color of minerals may vary greatly the streak is often fairly constant. The color of the streak may be determined by crushing, filing, or scratching. The usual and most satisfactory method, however, is to rub the mineral on a piece of white, unglazed porcelain, the *streak plate*. The ease or difficulty with which the streak is obtained is to some extent indicative of the hardness of a mineral.

The *rubbed streak* is obtained when glazed porcelain is used. It can be used to advantage to distinguish between graphite and molybdenite.

Hardness.—The resistance offered by a mineral to abrasion or scratching is termed hardness. It is indicated relatively in terms of Mohs's scale, which consists of ten common minerals arranged in order of increasing hardness, as follows:

1. Talc,
2. Gypsum,
3. Calcite,
4. Fluorite,
5. Apatite,
6. Feldspar,
7. Quartz,
8. Topaz,
9. Corundum,
10. Diamond.

Beryl, 7.5 to 8 in hardness, is often substituted for topaz in the above scale.

Substances, scratched by and which in turn scartch some one member of the scale, are said to have the hardness assigned to that member. In determining the hardness of a mineral the scratch made should be as short as possible, not over 1/4 inch, and care exercised to distinguish

between a scratch and a chalk mark, the latter being easily removed by rubbing.

The determination of the approximate hardness is greatly simplified by using the finger nail, copper coin, the knife blade, or a piece of window glass, which possess the following values:

Finger nail, up to 2.5
Copper coin, up to 3
Knife blade, up to 5.5.
Window glass, 5.5

Since the majority of the minerals are less than 6 in hardness, this simplified scale is of great convenience in determining the approximate hardness in the laboratory and field.

In the tables which follow on page 18, minerals have been divided into three groups based upon the hardness of two very common minerals, calcite and feldspar, thus: (1) 1 to 3, softer than or as hard as calcite; (2) 3 to 6, harder than calcite but not harder than feldspar; (3) over 6, harder than feldspar.

Crystallization.—Minerals are described in the tables as occurring in crystals or masses. Crystals are bounded wholly or in part by natural planes and may be divided into six groups called the crystal systems. Massive minerals are either crystalline or amorphous.

The crystal systems are characterized by their axes.

Cubic System.—Three equal and perpendicular axes. Some forms are the cube,* octahedron, dodecahedron, tetrahexahedron, tetragonal trisoctahedron, hexoctahedron, tetrahedron, and pyritohedron.

Hexagonal System.—Four axes, three of which are equal and horizontal, intersecting at 60°. The fourth is vertical, perpendicular to, and either longer or shorter than the horizontal axes. Common forms are prisms, bipyramids, pyramids, basal pinacoid, rhombohedron, and scalenohedron.

Tetragonal System.—Three axes, two of which are equal, horizontal, and perpendicular to each other. The third axis is vertical, perpendicular to, and either longer or shorter than the horizontal axes. The important common forms are prisms, bipyramids, pyramids, basal pinacoid, and bisphenoid.

Orthorhombic System.—Three unequal and perpendicular axes. The axis extending from front to rear is the brachyaxis, the one from right to left the macroaxis, while the third is the vertical axis. The names of the crystallographic forms often indicate the axis to which they are

* For a fuller description of some of the following terms see the glossary, page 11; also consult any standard textbook on crystallography or mineralogy.

parallel. Some common forms are prisms, bipyramids, pinacoids, and domes.

Monoclinic System.—Three unequal axes, two intersect obliquely, while the third is perpendicular to them. The axis from front to rear, held inclined to the observer, is the clinoaxis, the one from right to left the orthoaxis, while the third is the vertical axis. The common forms are prisms, hemipyramids, domes, hemidomes, and pinacoids. The specific names often indicate the axis to which the forms are parallel.

Triclinic System.—Three unequal and inclined axes, designated as in the orthorhombic system. Common forms are tetrapyramids, hemiprisms, hemidomes, and pinacoids.

Structure.—Many minerals occur frequently in good crystals, as is the case with calcite and quartz. But for the most part minerals are found in masses of various types, which may be either crystalline or amorphous in character. In fact, the general structure of minerals may be classified as follows:

1. Crystalloids	—Crystalline Structure	Crystals	—Crystal Aggregates. Example, calcite.
		Irregular Grains or Particles	—Crystalline Aggregates. Example, marble.
2. Colloids and Gels	—Amorphous Structure	—Masses	—Example, opal.

The term crystalloid refers to well-developed isolated crystals or to groups or *aggregates of crystals* and also to grains or particles possessing crystal structure but devoid of natural plane surfaces, which are one of the outward expressions of crystallinity. Masses of grains or particles are called *crystalline aggregates*. Colloids or gels do not crystallize and therefore yield only *amorphous masses*, which are without any definite form. Those masses which appear to the unaided eye to be amorphous but are, in reality, crystalline, as revealed by the microscope, are called *cryptocrystalline*.

Crystals occur in a great diversity of form. These forms are very useful in the determination of minerals. There are also many types of crystalline aggregates and amorphous masses, of which the following are the most important: *acicular*, *botryoidal*, *bladed*, *capillary*, *cleavable*, *columnar*, *compact*, *cryptocrystalline*, *fibrous*, *foliated*, *lamellar*, *mammillary*, *phanerocrystalline*, *reniform*, and *stalactitic*. These and other terms relating to structure are defined in the glossary, page 11.

Cleavage.—Many minerals split or separate easily along definite planes. This property is called *cleavage* and is frequently very conspicuous and highly characteristic. A mineral can be cleaved either by

striking it a properly directed blow with a hammer or by pressing upon it in a definite direction with the sharp edge of a knife blade. The planes along which the separation takes place are called *cleavage planes*. These planes are parallel to possible crystal faces and are so designated. Thus, cubical cleavage, that is, parallel to the faces of the cube, is shown by galena and halite; octahedral cleavage, by the diamond and fluorite; rhombic dodecahedral cleavage, by sphalerite; rhombohedral cleavage, by calcite; prismatic cleavage, by barite and celestite; basal cleavage, by topaz and mica; clinopinacoidal cleavage, by gypsum. The manner and ease with which cleavages are obtained are indicated by such terms as *perfect*, *imperfect*, *distinct*, *easy*, and so forth. Thus, calcite is said to have a perfect rhombohedral cleavage.

The cleavage of minerals, and especially of crystals, can often be recognized by the presence and direction of cleavage cracks. In such cases, it is not necessary to resort to striking the specimen a blow and, hence, shattering it somewhat, or to the use of a knife edge. As cleavage is dependent upon regularity of structure, it is observed only on crystallized substances. Amorphous substances do not possess cleavage.

The important cleavages in the various systems and the common minerals upon which they may be observed are given in the following table:

Cleavage	Mineral
Cubic System	
Cubical	Galena, halite
Rhombic dodecahedral	Sphalerite, sodalite
Octahedral	Fluorite, diamond, cuprite
Hexagonal System	
Rhombohedral	Calcite, dolomite, siderite
Basal	Beryl, apatite, nephelite
Prismatic	Apatite, nephelite
Tetragonal System	
Basal	Apophyllite
Prismatic, first order	Rutile, zircon, scapolite
Prismatic, second order	Rutile, scapolite
Pyramidal, first order	Scheelite, wulfenite
Pyramidal, second order	Scheelite
Orthorhombic System	
Basal	Anhydrite (pearly), barite, celestite, topaz
Brachypinacoidal	Anhydrite (vitreous), stibnite, orthorhombic pyroxenes
Macropinacoidal	Anhydrite (greasy to dull)
Prismatic	Barite, celestite, orthorhombic pyroxenes

Cleavage	Mineral
Monoclinic System	
Basal	Orthoclase, micas, chlorites, epidote
Clinopinacoidal	Orthoclase, gypsum, stilbite
Orthopinacoidal	Epidote
Prismatic	Amphiboles, pyroxenes
Triclinic System	
Basal	Plagioclases, microcline
Brachypinacoidal	Plagioclases, cyanite
Macropinacoidal	Cyanite

Parting.—This is a separation somewhat similar to cleavage and is sometimes called false cleavage. It is frequently the result of polysynthetic twinning. It may also be due to pressure applied in definite directions.

Fracture.—The fracture of a mineral refers to the character of the surface obtained when crystalline substances are broken in directions other than those along which cleavage or parting may take place. Minerals with no cleavage or with only a poor cleavage yield fracture surfaces very easily. As amorphous substances are devoid of cleavage, they always show fracture surfaces when shattered by a blow. The following types of fracture may be distinguished:

Conchoidal.—The surfaces are curved and shell-like in character. Example, quartz.

Even.—The fracture surfaces are flat or nearly so, that is, they are approximately even planes. Example, lithographic limestone.

Uneven.—The surfaces are more uneven. Example, rhodonite.

Hackly.—The fracture surfaces have many sharp points and are rough and irregular. Example, copper.

Splintery.—The mineral breaks into splinters or fibers. Example, pectolite.

Earthy.—The irregular fracture characteristic of earthy substances like chalk, kaolin, and bauxite.

Tenacity.—Under this heading is included the behavior of minerals when an attempt is made to break, cut, hammer, crush, bend, or tear them. The most important kinds of tenacity are the following:

Brittle.—Easily broken or powdered and cannot be cut into slices. Example, quartz.

Sectile.—Can be cut and yields shavings, which crumble when struck with a hammer. Example, gypsum.

Malleable.—Can be hammered out into thin sheets. Examples, gold and copper.

Ductile.—Can be easily drawn into wire. Examples, copper and silver.

Flexible.—Thin layers of the mineral can be bent without breaking, and they remain bent after the pressure has been removed. Example, foliated talc.

Elastic.—Thin layers of the mineral may be bent without breaking, but they resume their positions when the pressure is removed. Example, mica.

Transparency or Diaphaneity.—This is the ability of a mineral to transmit light. This property can usually be recognized upon first sight, as is also the case with color and luster. Substances through which objects can be easily and distinctly seen are said to be *transparent.* Example, colorless quartz. When light passes through the substance but objects are seen only indistinctly, the mineral is *translucent.* Example, Mexican onyx. Substances are *opaque* when no light is transmitted even through thin edges or layers. Example, graphite. *Subtransparent* and *subtranslucent* indicate intermediate stages.

Play or Change of Colors.—Some minerals exhibit different colors as the specimen is slowly turned, or as the direction of observation is changed. This is well illustrated by labradorite and opal.

Opalescence.—This consists of milky or pearly reflections from the interior of the specimen, as is frequently seen in opal and moonstone. Opalescence is usually observed to best advantage on specimens with rounded and polished surfaces.

Iridescence.—Some minerals show a play of bright colors due to a thin coating or film on the surface of the specimen, as is often the case with limonite. In some cases it is due to cleavage cracks.

Tarnish.—After certain minerals have been exposed to air, the color of the exposed portions differs distinctly from that of the freshly fractured surfaces. Example, bornite.

Asterism.—Some minerals, like certain sapphires and rubies, exhibit a starlike light effect when viewed in reflected light. Other minerals show a similar effect in transmitted light, that is, when a source of light is viewed by holding the specimen close to the eye, for example, muscovite.

Taste.—Minerals soluble in water or the saliva generally possess a characteristic taste, which may be designated as follows:

Acid.—The sour taste of sulphuric acid.

Alkaline.—The taste of soda or potash.

Astringent.—This causes a contraction or puckering. Example, alum.

Bitter.—The taste of epsom or bitter salts.

Cooling.—The taste of potassium or sodium nitrate.

Metallic.—A very disagreeable, brassy, metallic taste. Example, decomposed pyrite.

Pungent.—A sharp and biting taste. Example, ammonium chloride.

Saline.—The salty taste of halite or sodium chloride.

Although the taste of a mineral is not a property of great importance, it is sometimes very useful in the rapid determination of minerals.

Odor.—Some minerals give off characteristic odors when breathed upon, rubbed, scratched, pounded, or heated, which are designated as follows:

Argillaceous.—The claylike odor obtained by breathing upon kaolin.

Bituminous.—The odor produced by minerals containing bituminous or organic matter. Usually it is easily obtained by striking the specimen with a hammer. Example, asphalt.

Fetid.—The odor of rotten eggs, due to a liberation of hydrogen sulphide. Example, barite.

Garlic.—The odor of the vapors evolved when arsenical minerals are heated. Also called *alliaceous* or *arsenical* odor. Example, arsenopyrite.

Horse-radish.—The very disagreeable odor of decaying horse-radish obtained by heating compounds of selenium.

Sulphurous.—The odor of sulphur dioxide, which is liberated when sulphur or sulphides are heated or roasted. Example, pyrite.

Feel or Touch.—The impression one receives by handling or touching a mineral is designated as its *feel* or *touch.* The following terms are in common use.

Cold.—The feel of good conductors of heat. Examples, metallic minerals like copper and silver, and also some gems.

Greasy or Soapy.—The slippery feel of talc.

Harsh or Meager.—Rough to the touch. Example, chalk.

Smooth.—Without projections or irregularities. Example, meerschaum.

Some porous minerals like chalk, kaolin, and diatomaceous earth adhere readily to the tongue.

Magnetism.—Comparatively strong magnetism is shown by a few iron-bearing minerals, their powders or small fragments being readily attracted by a magnet. A convenient method to test the presence or absence of magnetism in a mineral, without crushing it, is to suspend a small horseshoe magnet from the finger, so that it may swing freely, and then bring the specimen under consideration close to the magnet. If the specimen is magnetic, the magnet will be deviated from its vertical position, the amount of the deviation indicating roughly the relative strength of the magnetism; examples, magnetite and pyrrhotite. Some minerals even act as natural magnets or lodestones and will attract

considerable quantities of iron filings, tacks, and nails; examples, certain varieties of magnetite.

Specific Gravity.—The specific gravity of a solid substance is its weight in air compared with the weight of an equal volume of water. The specific gravity of a mineral is constant, provided its composition does not vary. Many minerals with strikingly similar physical properties often possess specific gravities which differ materially. Thus, celestite, $SrSO_4$, with a specific gravity of 3.95 can be easily distinguished from barite, $BaSO_4$, having a specific gravity of 4.5.

The specific gravity of minerals can be determined most conveniently by means of the spiral spring balance, often known as the Jolly balance. An improved, recording model of this balance is illustrated in Fig. 1.[1] This balance consists of an upright tube to which the inner fixed vernier and the movable, doubly graduated scale are attached. Within this large tube there is a second, smaller tube which can be moved by the large milled-head. To this second tube the outer movable vernier is fastened. A movement of the inner tube upward carries the second vernier and the graduated scale with it. Within the second tube there is a rod of adjustable length, which carries the spiral spring, index, and scale pans. With this form of balance, only two readings and a simple division are necessary to determine the specific gravity.

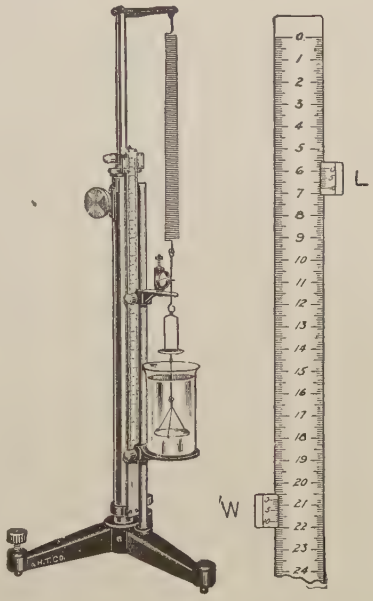

Fig. 1. Fig. 2.

In using the balance it is necessary that the graduated scale, the two verniers, and the index, which is attached to the spiral spring, all be at zero, the lower scale pan being immersed in water. This is accomplished by adjusting approximately, by hand, the length of the rod carrying the spring and then introducing the necessary correction by means of the micrometer screw shown directly below the spring in the cut, Fig. 2. A fragment is then placed on the upper scale pan, and by turning the large milled-head, the inner tube, graduated scale, and outer vernier are all driven upward until the index on the spring is again at zero. The fixed

[1] This balance is manufactured by Eberbach and Son Company, Ann Arbor, Michigan.

inner vernier W, Fig. 2, now records the elongation of the spring due to the weight of the fragment in air. The scale is then clamped by means of the screw at the lower end of it, Fig. 1. The fragment is now transferred to the lower scale pan, immersed in water, and the round tube lowered by the large milled-head until the index again reads at zero. During this operation, the outer vernier moves downward on the graduated scale, and its position may now be indicated by L, Fig. 2. This is obviously the decrease in the elongation of the spring due to the immersion of the fragment in water. The readings at W and L are all the data necessary for the calculation of the specific gravity. For

$$\textit{Specific gravity} = \frac{\textit{Weight in air}}{\textit{Loss of weight in water}} = \frac{W}{L}$$

It is also obvious that these readings are recorded so that they may be checked, if necessary, after the operations and calculation are completed.

By means of this balance, specific gravity determinations can be readily made in about two minutes, using for the purpose a crystal or larger mineral fragment as free from impurities as possible.

In order to determine the specific gravity of minerals in smaller fragments or grains, it is necessary to make use of the pycnometer or specific gravity flask, and the chemical balance, or the Westphal balance and certain heavy liquids. These methods are very accurate but time consuming. They are generally employed in mineralogical research and but rarely by students of elementary mineralogy.

GLOSSARY

This glossary contains the important terms generally used in describing minerals.

Acicular—needle-like.

Acid taste—sour taste of sulphuric acid.

Acute—sharply pointed.

Adamantine luster—like that of the diamond, or oiled glass.

Aggregate—mass, cluster, group.

Alkaline taste—like that of soda.

Allochromatic—having a color which is not an inherent property of the mineral, but due to pigments, inclusions, or other impurities, hence, variable.

Alluvial—relating to deposits made by flowing water.

Amorphous—devoid of crystallinity.

Amygdaloid—basic or dark colored igneous rock containing small cavities, which are filled entirely, or in part, with minerals of secondary origin.

Arborescent—branching, tree-like.

Argillaceous—clay-like odor.

Asterism—a star-like effect seen in either transmitted or reflected light.

Astringent taste—causing contraction or puckering.

Basal—parallel to the basal pinacoid.

Basalt—basic igneous rock, dark and compact.

Bipyramid—two pyramids placed base to base.

Bisphenoid—four-sided form of the tetragonal system, each face being an isosceles triangle.

Bituminous—odor due to the presence of bitumen or other organic matter.

Bladed—elongated and flattened, like a knife blade.

Botryoidal—closely united spherical masses, resembling a bunch of grapes.

Brachypinacoid—form with two faces in the orthorhombic or triclinic systems, parallel to the brachy and vertical axes.

Brittle—crumbles under knife or hammer, cannot be cut into slices.

Capillary—hair- or thread-like.

Carbonatization—formation of carbonates.

Cellular—porous, like a sponge.

Chatoyant—having a changeable, undulating, or wavy color or luster.

Clastic—made up of fragments.

Clay—fine, soft, aluminous sediments that are plastic.

Cleavable—capable of splitting in definite directions.

Cleavage—property of many crystalline substances of breaking or splitting in definite directions, yielding more or less smooth surfaces.

Clinopinacoid—form with two faces in the monoclinic system, parallel to the clino and vertical axes.

Colloid.—A non-crystalline or amorphous body.

Columnar—long thick fibers, often parallelly grouped.

Compact—closely or firmly united.

Complex crystals—highly modified, having many crystal forms or faces.

Concentric—spherical layers about a common center, similar to layers of an onion.

Conchoidal—curved, shell-like.

Concretion—rounded mass formed by accumulation about a center.

Concretionary—formed as a concretion.

Confused—indistinct, jumbled together.

Conglomerate—sedimentary rock, composed of rounded fragments, coarse and fine.

Contact mineral—formed under the influence of an igneous intrusion.

Crested—tabular crystals arranged in ridges.

Cruciform—in the form of a cross, cross-shaped.

Cryptocrystalline—finely crystalline, revealed only under the microscope.

Crystal—substance bounded, entirely or partially, by natural plane surfaces.

Crystalline—having crystal structure, but without definite geometrical form.

Crystallization—process of solidification in the form of well developed crystals, or in crystalline masses.

Crystalloid—well developed crystals, aggregates of crystals, or grains possessing crystalline structure.

Crystallography—study of crystal forms and properties.

Cubical—with the form of a cube.

Cyclic—repeated twinning yielding circular forms.

Decrepitate—to snap and break into fine powder when heated.

Dendritic—branching, fern-like.

Diaphaneity—ability to transmit light.

Dichroism—property of exhibiting different colors by transmitted light when viewed in two perpendicular directions.

Disseminated—scattered through a substance.

Divergent—radiating from a center.

Dodecahedral—pertaining to the rhombic dodecahedron, a form with twelve faces in the cubic system.

Domatic—relating to a dome, a horizontal prism.

Drusy—rough surface due to a large number of small, closely crowded crystals.

Ductile—capable of being drawn into wire. Ductile substances are also malleable and sectile.

Dull luster—not bright or shiny.

Earthy—without luster, dull.

Efflorescence—thin crust or coating, often powdery.

Elastic—capable of bending without breaking but resumes original position when the force is removed.

Eruptive rock—formed by the solidification of a surface flow of molten rock. Often used as a synonym of igneous.

Etched—corroded.

Felted—fibers closely matted.

Ferruginous—containing iron.

Fetid—emitting an offensive odor.

Fibrous—consisting of slender fibers or filaments.

Fissure—crack or crevice.

Flexible—capable of bending without breaking, and does not resume original position when the force is removed.

Fluorescence—property of emitting light when exposed to electrical discharges, or when heated.

Folia—having the form of thin plates or leaves.

Foliated—in plates or leaves which separate easily.

Fossiliferous—containing or composed of fossils.

Fracture—refers to surface obtained when breaking in a direction other than parallel to cleavage or parting.

Friable—easily crumbled or reduced to powder.

Furrowed—deeply striated, grooved.

Gangue—associates of more valuable minerals or ores.

Garlic—odor observed when arsenic minerals are heated.

Globular—spherical or nearly so.

Gneiss—laminated or foliated metamorphic rock consisting usually of quartz, feldsapr, and mica or hornblende.

Granite—coarsely crystalline igneous rock, consisting usually of quartz, feldspar (orthoclase or microcline), and mica or hornblende.

Granular—consisting of closely packed grains, either coarse or fine.

Guano—excrement of sea fowl.

Habit—development or form of crystals.

Hackly—rough surface, covered with sharp points.

Hardness—resistance offered to abrasion or scratching.

Harsh—rough to the touch.

Hemimorphic—having different planes about the two ends of a crystallographic axis.

Hexoctahedron—form of the cubic system having forty-eight faces.

Hopper shaped—cavernous and tapering, square funnel shaped.

Hydration—combining chemically with water.

Hygroscopic—property of absorbing moisture from the atmosphere.

Idiochromatic—minerals with a constant color, an inherent property.

Igneous rock—one formed by the solidification of a molten mass from within the earth.

Impregnated—finely disseminated and intimately mixed with rock.

Impressed—marked by pressure, indented.

Inclusion—foreign material enclosed within a mineral.

Incrustation—crust or coating on another substance.

Inelastic—not elastic.

Interlaced, **Interwoven**—intertwined, confused.

Iridescence—showing play of colors, usually due to thin film or coating.

Kimberlite—altered, very basic igneous rock, consisting essentially of serpentine, olivine, augite, pyrope; sometimes diamond-bearing.

Lamellæ, **Laminæ**—small, thin plates or layers, curved or straight.

Lamellar—consisting of lamellæ or laminæ.

Lava—molten rock, especially surface flows; also applied to the solidified product.

Lenticular—lens-shaped.

Limestone—sedimentary rock composed essentially of calcium carbonate, calcite.

Luster—manner in which the surface reflects light.

Macropinacoid—form with two faces in the orthorhombic or triclinic systems, parallel to the macro and vertical axes.

Macroscopic—visible to the unaided eye, opposed to microscopic.

Malleable—capable of being flattened by hammering.

Mammillary—rounded mass, larger than that of a grape.

Marble—recrystallized limestone or dolomite; may also include other limestones susceptible to a polish, and serpentine.

Massive—without definite crystal form; either crystalline or amorphous.

Meager—rough touch.

Metallic luster—simulating a metal and exhibited by minerals which are opaque or nearly so, and quite heavy.

Metallic taste—disagreeable, brassy taste.

Metalloidal—having the appearance of a metal.

Metamorphic rock—one that has been altered by heat, pressure, liquids, or gases, so as to render its texture either crystalline or schistose.

Meteorite—mass of stone or iron which has fallen to the earth from outer space.

Micaceous—composed of very thin plates or scales, like those of mica.

Mimicry—imitation of forms of a higher symmetry by those of lower grade of symmetry, usually the result of twinning.

Modified, highly—consisting of a large number of crystal forms or faces.

Monochromatic—homogeneous light of a definite wave-length.

Mottled—spotted.

Multi-colored—having many colors.

Nodular, **Nodule**—rounded mass of irregular shape.

Nugget—rounded, irregular lump, especially of a metal.

Ocherous—earthy, and usually red, yellow, or brown in color.

Octahedral—pertaining to the octahedron, eight-sided form of the cubic system.

Oolitic—rounded particles the size of fish-eggs.

Opalescent—with milky or pearly reflections.

Opaque—will not transmit light even through thin layers or edges.

Orthopinacoid—form with two faces in the monoclinic system, parallel to the ortho and vertical axes.

Oxidation—combining chemically with oxygen.

Parameters—linear intercepts of a crystal face on the crystallographic axes.

Parting—false cleavage, usually the result of twinning.

Pearly—similar to the luster of mother of pearl.

Peat—dark brown to black substance, formed by the partial decomposition of vegetable tissue in marshes.

Pegmatite—very coarse grained acid igneous rock, consisting essentially of quartz, feldspar, and mica.

Peridotite—very basic igneous rock, composed largely of olivine and augite or hornblende.

Phanerocrystalline—crystals or coarsely crystalline.

Phonolite—compact extrusive rock, consisting essentially of orthoclase, nephelite and pyroxene.

Pinacoidal—relating to forms with two planes, parallel to two or more crystallographic axes.

Pisolitic—composed of small, rounded masses, the size of peas.

Pitchy—resembling pitch.

Placers—sands and gravels containing minerals of economic importance.

Plastic—capable of being molded or shaped.

Plates—broad, relatively thin masses.

Platy—consisting of plates.

Plumose—feathery.

Pocket—cavity in a rock, often filled with minerals.

Polysynthetic—consisting of thin lamellæ due to repeated twinning.

Prismatic—elongated parallel to one of the crystallographic axes, usually the vertical axes.

Pseudo—false.

Pseudomorph
Pseudomorphous } possessing the geometrical form of another mineral.

Pungent—sharp, biting.

Pyramidal—pertaining to the pyramid, a form which usually intersects three crystallographic axes.

Pyritohedron—form of the cubic system with twelve, five-sided faces.

Rectangular—intersecting at 90°.

Reduction—loss of oxygen chemically.

Refraction, double—yielding two refracted rays.

Reniform—large, rounded masses, kidney-shaped.

Resinous—luster of resin, greasy.

Reticulated—fibers crossing like a net.

Rhombic—diamond-shaped.

Rhombohedral—relating to the rhombohedron, a form of the hexagonal system, with six faces intersecting at angles other than 90°.

Rosette—simulating a rose.

Saline—salty.

Sandstone—sedimentary rock consisting of consolidated sand.

Scalenohedral—relating to the scalenohedron, a twelve-sided form of the hexagonal system, each face being a scalene triangle.

Scaly—consisting of scales.

Schiller—peculiar bronze-like luster.

Schist—metamorphic rock with foliated or parallel structure, splitting easily along certain planes.

Seam—narrow vein.

Sectile—capable of having slices cut off.

Semi-opaque—between opaque and transparent.

Shale—laminated sedimentary rock, consisting of hardened muds, silts, or clays.

Sheaf-like—resembling a sheaf of wheat.

Silky—luster of silk, due to fibrous structure.

Skeletal—pertaining to crystals with incomplete development of their faces, often with cavernous appearance.

Slate—dense, fine grained metamorphic rock, which splits easily into broad, thin layers or sheets.

Splendent—very bright by reflected light.

Splintery—breaking into splinters.

Stalactitic—cylindrical or conical masses resembling icicles.

Stalky—consisting of long, stout fibers.

Stellate—radiating from a center producing star-like forms.

Streak—color of fine powder, usually obtained by rubbing the mineral on unglazed porcelain.

Subadamantine—imperfectly adamantine.

Subconchoidal—imperfectly conchoidal.

Sublimation—direct solidification from a vapor.

Submetallic—imperfectly metallic.

Syenite—granular igneous rock, commonly consisting of orthoclase and hornblende or biotite.

Tabular—flat, tablet-like.

Tarnish—thin film formed on the surface when exposed to air and different in color from that of the fresh fracture.

Tenacity—refers to behavior of minerals when an attempt is made to crush, bend, cut or tear them.

Terminations—faces on the end of a crystal.

Tetragonal trisoctahedron—form of the cubic system with twenty-four trapezohedral faces.

Tetrahedral—pertaining to the tetrahedron, a four-sided form of the cubic system.

Tetrahexahedron—form of the cubic system with twenty-four triangular faces.

Tough—not easily broken.

Translucent—when light passes through, but objects can not be seen distinctly.

Transparency—refers to the amount of light passing through a substance.

Transparent—when sufficient light passes through the substance so that objects may be distinctly seen.

Trap—dark or basic, fine grained igneous rock.

Trichroism—property of exhibiting different colors by transmitted light when viewed in three perpendicular directions.

Trillings—intergrowth of three crystals in a symmetrical manner.

Twinned—crystals consisting of more than one individual, arranged in a definite manner.

Twins—Symmetrical intergrowth of two crystals.

Variegated—with different colors.

Vein—crack or fissure, partially or completely filled with mineral matter.

Vitreous luster—like that of glass.

Warty—small, rounded masses resembling warts.

Waxy—luster of wax.

Zonal—in zones or layers.

DIRECTIONS FOR USING THE TABLES

These tables for the determination of minerals depend largely upon the use of those physical properties that are easily, rapidly, and accurately recognizable at sight. As luster and color can be determined at first glance, they are made the basis of the tables. Thus, the minerals are divided into two large groups depending upon whether they possess a metallic or non-metallic luster. Minerals with metalloidal or submetallic lusters are listed in both divisions. Each of these groups is then subdivided according to color, the other property readily recognized at first glance. There are also further sub-groupings according to streak, and then according to increasing hardness. Within each of the latter smaller subdivisions the minerals are listed with reference to increasing specific gravity.

To illustrate the use of the tables let us assume that we have a specimen of magnetite. As the luster is metallic and the color black, the mineral falls into group 1, page 18. The streak is then determined and is found to be black. Consequently it is placed in the second subdivision under streak. The hardness is next tested and found to be 6. Accordingly, reference should be made to page 38, where the minerals with metallic luster, black color and streak, and hardness over 3 are listed with concise descriptions. The hardness column is now followed until values of 6 or thereabouts are encountered. At this point it becomes necessary to determine the various other properties, such as crystallization, structure, transparency, cleavage, fracture, tenacity, and specific gravity, as well as the general characteristics and associates. A comparison of these observations with the descriptions of the various minerals with a hardness of approximately 6 should lead readily to an accurate determination.

A. MINERALS WITH METALLIC LUSTER

Color of mineral	Streak	Hardness	Pag
1. Dark gray or black	White, gray, green, red, brown, or yellow	1 to 3	20
		3 to 6	22
		Over 6	30
	Black	1 to 3	34
		Over 3	38
2. Metallic white or light metallic gray	Metallic white or steel gray	1 to 3	44
		Over 3	44
	Black	1 to 3	46
		Over 3	48
3. Yellow	Gray, brown, or yellow	1 to 6	52
	Black	Over 3	54
4. Brass, bronze, or copper red	Gray, red, or yellow	1 to 3	58
	Black	Over 3	58
5. Red, brown, or blue	White, gray, green, red, brown, or yellow	1 to 3	62
		3 to 6	64
		Over 6	68
	Black	1 to 6	70

B. MINERALS WITH NON-METALLIC LUSTER

Color of mineral	Streak	Hardness	Page
ark gray or black	Green, red, brown, yellow, or black	1 to 3	72
		3 to 6	74
		Over 6	78
	Uncolored, white, or light gray	1 to 3	80
		3 to 6	82
		Over 6	88
nk, red, or red violet	Pink, red, brown, or yellow	1 to 3	96
		Over 3	98
	Uncolored, white, or light gray	1 to 3	102
		3 to 6	108
		Over 6	120
reen, blue, or blue violet	Blue, green, brown, yellow, or black	1 to 3	128
		Over 3	130
	Uncolored, white, or light gray	1 to 3	134
		3 to 6	142
		Over 6	154
llow or brown	Red, brown, yellow, or black	1 to 3	166
		Over 3	168
	Uncolored, white, or light gray	1 to 3	174
		3 to 6	184
		Over 6	202
lorless, white, or light gray	Uncolored, white, or light gray	1 to 3	212
		3 to 6	224
		Over 6	242

Streak—White, gray, green, red, brown, or yellow

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Ozocerite (Mineral wax, native paraffin) C_nH_{2n+2}	Never in crystals **M**—Compact, fibrous, lamellar	Submetallic Waxy Translucent	Black Brownish black
Wad MnO_2, H_2O, etc.	Amorphous? **M**—Earthy, sometimes with globular structure	Dull Submetallic Opaque	Brownish black Black
Lignite (Brown coal) C, H, O, etc.	Amorphous **M**—Compact, fibrous; commonly with woody structure	Dull Opaque	Black Brownish black
CHLORITE (Prochlorite, clinochlorite) $H_8Mg_5Al_2Si_3O_{18}$?	Monoclinic **C**—Tabular, six-sided, often bent and twisted **M**—Foliated, scaly, granular, earthy	Dull Submetallic Translucent to opaque	Black Greenish black
HEMATITE, variety *Specular iron ore* Fe_2O_3	Hexagonal **C**—Thin tabular, often in parallel position **M**—Scaly, micaceous, platy, foliated	Metallic Splendent Opaque, to translucent	Iron black Dark steel gray
BIOTITE (Black mica) $(K,H)_2(Mg,Fe)_2(Al,Fe)_2(SiO_4)_3$	Monoclinic **C**—Tabular, with hexagonal or rhombohedral habit **M**—Plates, scales	Submetallic Pearly Opaque to transparent	Black Brownish black Greenish black
Pyrargyrite Ag_3SbS_3	Hexagonal **C**—Small, complex, hemimorphic, rare **M**—Compact, disseminated, bands, crusts	Metallic Adamantine Opaque to transparent	Dark lead
SILVER Ag	Cubic **C**—Small, often distorted **M**—Grains, scales, plates, twisted hair- or wire-like forms	Metallic Opaque	Dark gray black exposu otherv silver wh

Hardness 1 to 3

Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
Yellowish brown	C—None, apparently amorphous Plastic; may be sticky	0.9 1.0	Easily indented by finger nail. Resembles impure wax. Greasy feel. In sandstones and shales. With petroleum and coal.
Dark brown Blackish brown	F—Earthy Brittle	3. 4.3	May soil fingers. Apparently very light and floats on water, due to porosity. Usually adheres to tongue. With psilomelane, pyrolusite, siderite, limonite.
Brown Blackish brown	F—Conchoidal Brittle to tough	1.1 1.4	More or less carbonized plant remains. May disintegrate on exposure. *Jet*, compact, coal black variety with resinous luster.
Pale green	C—Basal, perfect; when foliated, conspicuous F—Scaly, earthy Tough to brittle	2.6 3.	Laminæ are flexible but inelastic, with soapy feel. In schists and serpentine. With magnetite, garnet, diopside, magnesite. Pseudomorphous after garnet.
Cherry red Reddish brown	C—None, but distinct parting F—Uneven	4.9 5.3	Bright, shiny scales, often loosely compact; foliated or micaceous masses. In metamorphic rocks or as sublimation product around volcanoes.
White Grayish	C—Basal, perfect, conspicuous Tough, laminæ of fresh biotite very elastic	2.7 3.2	Easily recognized by structure, highly perfect cleavage, and elasticity. Important constituent of many igneous and metamorphic rocks—granite, gneiss.
Cherry red Purplish red	C—Imperfect F—Conchoidal Brittle	5.8	Frequently as gray or dark red bands, known as *dark ruby silver ore*. With proustite; in veins with other silver minerals and galena.
Silver white to light lead gray, darker after exposure	C—None F—Hackly Malleable, ductile	10. 12.	With silver, lead, arsenic, cobalt, and nickel minerals—argentite, pyrargyrite, proustite, smaltite, galena; also fluorite, calcite, barite.

Streak—White, gray, green, red, brown, or yellow

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
TETRAHEDRITE $Cu_8Sb_2S_7$	Cubic **C**—Tetrahedral, often highly modified **M**—Granular, compact	Metallic Opaque	Dark steel gray Iron black
Uraninite (Pitchblende) UO_3, UO_2, PbO, etc.	Cubic **C**—Octahedral, rare **M**—Botryoidal, columnar, curved lamellar, granular, compact; apparently amorphous.	Pitch-like Submetallic Dull Opaque	Pitch blac Brownish black Greenish black
Alabandite MnS	Cubic **C**—Rare **M**—Granular, compact	Submetallic Dull Opaque	Iron black
SIDERITE $FeCO_3$	Hexagonal **C**—Rhombohedral, curved or saddle-shaped, common **M**—Cleavable, granular, compact, botryoidal, rarely fibrous	Metalloidal Dull Opaque to translucent	Brownish black Black
SPHALERITE (Black Jack) ZnS	Cubic **C**—Tetrahedral, common, often very complex **M**—Compact, cleavable, fine or coarse granular	Submetallic Resinous Opaque to translucent	Black Yellowish black Brownish black
MANGANITE MnO.OH	Orthorhombic **C**—Columnar, prismatic, vertically striated; often in groups or bundles **M**—Columnar, granular, stalactitic	Metallic Submetallic Opaque	Iron black Dark st gray
***CUPRITE** Cu_2O	Cubic **C**—Octahedrons, dodecahedrons, alone or in combination **M**—Granular, earthy	Adamantine Dull Translucent to opaque	Reddish b Black

* Uncommon color.

Hardness 3 to 6

Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
Reddish brown	C—Indistinct F—Uneven Brittle	4.3 5.4	Crystals have characteristic tetrahedral habit. Sometimes coated with chalcopyrite. With sphalerite, galena, bournonite, chalcopyrite, siderite.
Dark brown Olive green	F—Conchoidal, uneven Brittle	4.8 9.7	Pitch-like appearance and fracture important. Fresh material is hard and heavy. With ores of lead, silver, and bismuth; also thorite, orthite, fergusonite.
Olive green	C—Cubical, not conspicuous F—Uneven Brittle	3.9 4.	Color may tarnish brownish black. Streak characteristic. With rhodochrosite, galena, pyrite, argentite, sphalerite.
Yellowish brown	C—Rhombohedral, perfect, conspicuous F—Conchoidal Brittle	3.7 3.9	Distinguished from sphalerite by curved crystals and rhombohedral cleavage. In ore deposits; beds and concretions in limestones and shales. With pyrite, chalcopyrite, galena, tetrahedrite, cryolite.
Dark brown Yellowish brown Grayish	C—Dodecahedral, perfect, usually conspicuous F—Conchoidal Brittle	3.9 4.2	Color and streak vary with impurities. Extensively in limestone. With galena, chalcopyrite, pyrite, barite, fluorite, siderite, rhodochrosite, smithsonite.
Reddish brown Blackish brown	C—Brachypinacoidal, perfect F—Uneven Brittle	4.2 4.4	Alters easily to pyrolusite, hence, surface may give black streak. With other manganiferous minerals; also barite, calcite, siderite.
Brownish red Dirty brown	C—Indistinct F—Uneven Brittle	5.7 6.1	Easily recognized by associates. Usually with other copper minerals—malachite (green), azurite (blue), chalcocite and melaconite (black), native copper.

Streak—White, gray, green, red, brown, or yellow

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
THORITE (Orangite) $ThSiO_4$	Tetragonal C—Square prisms with bipyramids M—Compact, disseminated	Submetallic Vitreous Opaque to translucent	Black Brownish black
Goethite FeO.OH	Orthorhombic C—Small, thin tabular, needle-like; parallelly grouped M—Reniform, stalactitic	Submetallic Translucent to opaque	Brownish black Black
* **TITANITE** (Sphene) $CaTiSiO_5$	Monoclinic C—Wedge- or envelope-shaped; also tabular or prismatic M—Compact, lamellar	Submetallic Vitreous Opaque to translucent	Black Brownish black
LIMONITE $Fe_2O_3.nH_2O$	C—Always pseudomorphs, commonly after pyrite, marcasite, siderite M—Compact, stalactitic, botryoidal, reniform; often with radial fibrous structure	Metallic Dull Opaque	Black Brownish black
Hausmannite Mn_2MnO_4	Tetragonal C—Acute pyramidal, cyclic twins not uncommon M—Granular, compact	Metallic Greasy Opaque	Black Brownish black
Huebnerite $MnWO_4$	Monoclinic C—Long fibrous, bladed, stalky; often divergent, without good terminations M—Compact, lamellar, granular	Submetallic Resinous Translucent to opaque	Brownish black Black
WOLFRAMITE $(Fe,Mn)WO_4$	Monoclinic C—Thick tabular, short columnar, often large M—Bladed, curved lamellar, granular	Submetallic Metallic Opaque	Dark gray Brownish black Iron black

* Uncommon color.

Hardness 3 to 6

Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
Light orange Dark brown	C—Prismatic, not conspicuous F—Conchoidal Brittle	4.4 5.4	Dark brown to black thorite sometimes contains nucleus of *orangite*, yellow to orange in color. Thorite believed to be decomposed orangite.
Yellow Yellowish brown	C—Brachypinacoidal, perfect F—Uneven, splintery Brittle	4. 4.4	Usually with other iron ores; in cavities in hematite or limonite. Crystals and cleavage distinguish it from limonite. Often as scaly, fibrous, velvety crusts.
White Gray	C—Prismatic F—Conchoidal Brittle	3.4 3.6	Generally in crystals. With feldspars, pyroxenes, amphiboles, chlorite, scapolite, zircon, apatite.
Yellowish brown	F—Conchoidal, splintery Brittle	3.6 4.	Often with black varnish-like surface, passing into the soft, yellow earthy or ocherous variety. With pyrite, hematite, magnetite, goethite, siderite. Pseudomorphs after pyrite very common.
Chestnut brown	C—Basal, perfect F—Uneven Brittle	4.7 4.8	Steep, horizontally striated, octahedral-like bipyramids and complex twins. With manganese minerals—pyrolusite, psilomelane, braunite; magnetite, barite, hematite.
Yellowish brown Greenish gray	C—Clinopinacoidal, perfect, conspicuous Brittle	6.7 7.3	Structure, cleavage, and specific gravity important. Compare wolframite. In quartz veins, with fluorite, pyrite, scheelite, galena, tetrahedrite.
Dark red brown	C—Clinopinacoidal, perfect, conspicuous F—Uneven Brittle	7.1 7.5	Distinguished from huebnerite by streak. Powder may be slightly magnetic. With cassiterite, quartz, mica, fluorite, apatite, scheelite, molybdenite, huebnerite.

Streak—White, gray, green, red, brown, or yellow

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Ferberite $FeWO_4$	Monoclinic **C**—Wedge shaped, short prismatic, tabular **M**—Fan shaped aggregates, bladed, granular, compact	Submetallic Splendent Opaque	Iron black Brownish black
HORNBLENDE (Amphibole) Silicate of Ca, Mg, Fe, Al, etc.	Monoclinic **C**—Long prismatic, prism angle 124°; often with rhombohedral-like terminations **M**—Bladed, fibrous, granular, compact	Submetallic Vitreous Opaque to translucent	Pitch blac Greenish black Brownish black
PYROXENES **AUGITE** Silicate of Ca, Mg, Fe, Al, etc.	Monoclinic **C**—Short prismatic, thick columnar, prism angle 87° **M**—Compact, granular, disseminated	Submetallic Vitreous Opaque to translucent	Pitch blac Greenish b Brownish black
PYROXENES **Hypersthene** $(Fe,Mg)_2(SiO_3)_2$	Orthorhombic **C**—Prismatic, tabular, rare **M**—Granular, foliated, cleavable aggregates	Metalloidal Pearly Opaque to translucent	Black Brownish black Greenish b
Psilomelane MnO_2, BaO, H_2O, etc.	Amorphous ? **M**—Botryoidal, reniform, stalactitic; smooth surfaces	Metallic Dull Opaque	Iron black Bluish bla Dark gray
Ilmenite (Menaccanite) $FeTiO_3$	Hexagonal **C**—Thick tabular, rhombohedral **M**—Thin plates, granular, compact; disseminated grains; pebbles or sand	Metallic Submetallic Opaque	Iron black Brownish black

Hardness 3 to 6

Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
Dark brown	C—Clinopinacoidal, perfect F—Uneven Brittle	7.5	In granites and pegmatities. With quartz, chalcopyrite, galena, scheelite.
Gray Grayish green Grayish brown Yellow	C—Prismatic, perfect, conspicuous—124° Brittle	2.9 3.3	Simple, pseudohexagonal crystals, and cleavages at 56° and 124° important. Very common and in nearly all types of rocks. With calcite, feldspars, quartz, pyroxenes, chlorite.
Grayish green Gray	C—Prismatic, perfect, conspicuous —87° Brittle	3.2 3.6	Crystals usually eight-sided, more rarely four-sided. Pseudotetragonal, with prism angles of 87° and 93°. Cleavage less distinct than on hornblende. Common in basic eruptive rocks and crystalline limestones.
White Grayish	C—Brachypinacoidal, perfect, conspicuous F—Uneven Brittle	3.3 3.5	Copper red iridescence often noted, due to small tabular inclusions. Commonly in the more basic igneous rocks; with feldspar (labradorite), olivine, hornblende, pyrrhotite, magnetite.
Dark brown Blackish brown	F—Conchoidal, uneven Brittle	3.7 4.7	Often with fine sooty coating of pyrolusite. With other manganese minerals; limonite, barite.
Dark brown Reddish brown	C—None, partings may be noted F—Conchoidal Brittle	4.3 5.5	Often slightly magnetic. With hematite, magnetite, apatite, serpentine, titanite, rutile, quartz. Common in black sands.

Streak—White, gray, green, red, brown, or yellow

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
SAMARSKITE $M_3''M_2'''(Nb,Ta)_6O_{21}$ M'' = Fe, Ca, UO_2, etc M''' = Ce, Y, etc.	Orthorhombic **C**—Rare **M**—Compact, apparently amorphous; disseminated grains	Submetallic Greasy Opaque	Velvet bla Black
CHROMITE $(Fe,Cr)\ [(Cr,Fe)O_2]_2$	Cubic **C**—Octahedral, rare **M**—Compact, granular, disseminated	Submetallic Pitchy Opaque	Iron black Brownish black
Orthite (Allanite) $Ca_2(Al,Ce,Fe)_2(Al.OH)(SiO_4)_3$	Monoclinic **C**—Tabular, rare **M**—Compact, granular, bladed, disseminated grains	Submetallic Greasy Opaque to translucent	Black Pitch black Brownish black
Anatase (Octahedrite) TiO_2	Tetragonal Only in crystals,—pyramidal, tabular; rarely prismatic	Metallic Adamantine Opaque to translucent	Black Brownish black Reddish bl
Brookite TiO_2	Orthorhombic Only in crystals,—pyramidal (often with hexagonal habit), prismatic, tabular	Metallic Adamantine Opaque	Iron black Reddish bl Brownish black
Perovskite $CaTiO_3$	Pseudocubic **C**—Apparently cubes, highly modified, often striated **M**—Reniform aggregates, rounded grains	Metallic Adamantine Opaque	Black Grayish bl Brownish black
HEMATITE, varieties Fe_2O_3 *Specular iron ore* *Compact* *Martite* *Argillaceous*	Hexagonal **C**—Pyramidal, tabular, rhombohedral **M**—Compact, granular, micaceous, columnar, splintery, radiated reniform or botryoidal	Metallic Dull Opaque	Iron black Reddish b Dark steel

Hardness 3 to 6

d-s	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
	Reddish brown Yellowish brown	F—Conchoidal, conspicuous Brittle	5.6 5.8	Splendent luster, conchoidal fracture, and apparently amorphous structure important. With columbite, feldspars.
5	Dark brown Grayish brown	C—Octahedral, indistinct F—Uneven, conchoidal Brittle	4.3 4.6	May be slightly magnetic. Pitch-like appearance. With serpentine, talc, chrome garnet, zaratite; also in black sands and platinum placers.
5	Grayish Brownish gray Pale brown	C—Pinacoidal, indistinct F—Uneven, conchoidal Brittle	3. 4.	Often coated with yellowish or brownish alteration product. Disseminated in the more acid igneous rocks; also in limestones. With magnetite, epidote, quartz, feldspars.
5	Gray White	C—Pyramidal, basal, perfect F—Subconchoidal Brittle	3.8 3.9	Crystals often resemble elongated octahedrons. With brookite, rutile, ilmenite, adularia, titanite, gold.
5	Pale yellowish brown Gray	C—Indistinct F—Uneven Brittle	3.8 4.1	Crystals may be deeply striated. Not twinned like rutile. With rutile, anatase, titanite, ilmenite adularia, nephelite.
5	White Grayish	C—Cubical, fairly distinct F—Uneven Brittle	4. 4.1	With chlorite, magnetite, limestone, serpentine.
5	Cherry red Reddish brown	C—None, parting sometimes noted F—Uneven, splintery Brittle	4.9 5.3	*Specular iron ore*, crystals or sparkling scales and grains, often with iridescent tarnish; *compact hematite*, fibrous, columnar, reniform; *martite*, octahedral crystals, pseudomorphous after magnetite; *argillaceous hematite*, impure from sand, clay, jasper.

Streak—White, gray, green, red, brown, or yellow

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
FRANKLINITE $(Fe,Mn,Zn)(FeO_2)_2$	Cubic **C**—Octahedron, alone or with dodecahedron; rounded edges **M**—Compact, granular, rounded grains	Metallic Dull Opaque	Iron black
FERGUSONITE $Y(Nb,Ta)O_4$	Tetragonal **C**—Pyramidal, rare **M**—Disseminated grains	Submetallic Vitreous Dull Translucent to opaque	Brownish black

Streak—White, gray, green, red, brown, or yellow

Aegirite (Pyroxene) $NaFe(SiO_3)_2$	Monoclinic **C**—Prismatic **M**—Fibrous, acicular; often in tufts	Submetallic Vitreous Opaque to translucent	Greenish bl Brownish bl
HEMATITE. varieties *Specular iron ore* *Compact* *Martite* *Argillaceous* Fe_2O_3	Hexagonal **C**—Pyramidal, tabular, rhombohedral **M**—Compact, granular, micaceous, columnar, splintery, radiated reniform or botryoidal	Metallic Dull Opaque	Iron black Reddish bla Dark steel g
FRANKLINITE $(Fe,Mn,Zn)(FeO_2)_2$	Cubic **C**—Octahedron, alone or with dodecahedron; rounded edges **M**—Compact, granular, rounded grains	Metallic Dull Opaque	Iron black
COLUMBITE (Tantalite) $(Fe,Mn)[(Nb,Ta)O_3]_2$	Orthrohombic **C**—Short prismatic, tabular **M**—Compact, disseminated	Submetallic Greasy Dull Opaque	Iron black Brownish black
RUTILE TiO_2 or $TiTiO_4$	Tegragonal **C**—Prismatic, vertically striated; knee-shaped or rosette twins **M**—Compact, disseminated	Metallic Adamantine Opaque to translucent	Iron black Brownish black Reddish bl

Hardness 3 to 6

rd-ss	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
5	Reddish brown Dark brown	C—Octahedral, indistinct F—Conchoidal Brittle	5. 5.2	Powder frequently slightly magnetic. Distinguished by associates—willemite (yellow to green), zincite (red), rhodonite (flesh red), calcite.
5	Pale brown Dirty brown	F—Conchoidal, uneven Brittle	5.8 5.9	Luster on fresh fracture submetallic, otherwise dull. Less common than columbite. With quartz, zircon, gadolinite.

Hardness over 6

5	Grayish	C—Prismatic, perfect F—Uneven Brittle	3.5	In pegmatites and igneous rocks. With leucite, nephelite, feldspars. With blunt end faces, *aegirite;* with acute, *acmite.*
5	Cherry red Reddish brown	C—None, parting sometimes noted F—Uneven, splintery Brittle	4.9 5.3	*Specular iron ore,* crystals or sparkling scales and grains, often with iridescent tarnish; *compact hematite,* fibrous, columnar, reniform; *martite,* octahedral crystals, pseudomorphous aftermagnetite; *argillaceous hematite,* impure from sand, clay, jasper.
5	Reddish brown Dark brown	C—Octahedral, indistinct F—Conchoidal Brittle	5. 5.2	Powder may be slightly magnetic. Distinguished by associates—willemite (yellow to green), zincite (red), rhodonite (flesh red), calcite.
5	Reddish brown Blackish brown	C—Pinacoidal, not conspicuous F—Conchoidal, uneven Brittle	5.4 6.4	Fracture surface sometimes iridescent. With beryl, tourmaline, spodumene, cryolite. Tantalum predominates in *tantalite,* with a specific gravity up to 8.
	Pale yellowish brown Gray	C—Prismatic, pyramidal, not conconspicuous F—Uneven Brittle	4.2 4.3	Not as heavy as cassiterite. Sometimes in fine hair-like inclusions. Widely distributed. With quartz, feldspar, hematite, ilmenite, chlorite, brookite, apatite.

Streak—White, gray, green, red, brown, or yellow

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Gadolinite $Fe[Be(Y.O)SiO_4]_2$	Monoclinic **C**—Prismatic, rough, rare **M**—Compact, disseminated	Submetallic Translucent to opaque	Black Greenish black
CASSITERITE, varieties *Ordinary* SnO_2 or $SnSnO_4$ *Stream tin*	Tetragonal **C**—Thick prismatic, knee-shaped twins, common **M**—Compact, reniform, botryoidal, rounded pebbles	Submetallic Dull Translucent to opaque	Black Brownish black
Piedmontite $Ca_2(Mn,Al)_2(Al.OH)(SiO_4)_3$	Monoclinic **C**—Prismatic, similar to to epidote **M**—Columnar, radial aggregates	Submetallic Translucent to opaque	Reddish br Reddish bl
GARNET, varieties *Andradite* $M_3''M_2'''(SiO_4)_3$ *Almandite* $M'' = Ca,Fe,Mg$ $M''' = Al,Fe$	Cubic **C**—Dodecahedrons, tetragonal trisoctahedrons, alone or in combination **M**—Granular, compact, lamellar, disseminated; sand	Submetallic Translucent to opaque	Velvet blac Brownish black
TOURMALINE, variety *Schorl* $M'_{20}B_2Si_4O_{21}$ $M' = Na,K,Li,Mg,Ca,(OH),Fe,Al$	Hexagonal **C**—Prismatic, vertically striated, with broken or rhombohedral-like end surfaces **M**—Compact, divergent columnar, disseminated	Submetallic Pitchy Opaque	Pitch black Brownish black Bluish blac
CORUNDUM, variety *Emery* Al_2O_3 with Fe_3O_4, Fe_2O_3, SiO_2	Hexagonal **M**—Fine to coarse granular	Metallic Dull Opaque	Dark gray Black

Hardness over 6

Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
Greenish gray	**C**—None **F**—Conchoidal, splintery Brittle	4.5	In granitic rocks and pegmatites, with fergusonite, orthite, fluorite, molybdenite.
Pale brown Pale yellow White	**C**—Prismatic, imperfect **F**—Uneven Brittle	6.8 7.	Distinguished by high specific gravity and hardness. In veins cutting granite, gneiss; also in alluvial deposits, as *stream tin.* With quartz, wolframite, scheelite, arsenopyrite, molybdenite, tourmaline, fluorite, apatite, mica, chlorite.
Cherry red Red brown	**C**—Basal **F**—Uneven Brittle	3.4	In gneiss and schists with quartz, chlorite, braunite, tremolite, glaucophane.
White	**C**—Dodecahedral, indistinct **F**—Conchoidal, uneven Brittle	3.8 4.2	*Andradite,* commonly with magnetite, epidote, feldspars, nephelite, leucite; *almandite,* with mica, staurolite, andalusite, cyanite, tourmaline.
White Gray	**C**—None **F**—Conchoidal, uneven Brittle	2.9 3.2	Spherical triangular cross-section and hemimorphic development important. In pegmatites; metamorphic rocks; alluvial deposits. With quartz, feldspar, cassiterite, beryl, topaz, fluorite.
Yellowish brown Blackish brown	**C**—Indistinct **F**—Uneven Brittle to tough	3.7 4.3	Corundum mixed with magnetite, hematite, quartz. Resembles iron ore, powder may be magnetic. Properties vary. With mica, amphiboles, chlorite, spinel; in crystalline limestones, schists, peridotite.

Streak—White, gray, green, red, brown, or yellow

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
SPINEL, varieties *Pleonaste* $M_2''(M'''O_2)_2$ *Hercynite* R'' = Mg, Fe, *Gahnite* Zn, Mn *Picotite* R''' = Al, Fe *Dysluite*	Cubic **C**—Octahedral, well developed, common **M**—Compact, granular, disseminated grains; sand	Submetallic Dull Nearly opaque	Black Brownish black Greenish black

Streak—Black

Molybdenite MoS_2	Hexagonal **C**—Tabular, rare **M**—Disseminated grains, scales, foliated	Metallic Opaque	Bluish lead gray
GRAPHITE (Plumbago, black lead) C	Hexagonal **C**—Tabular, rare **M**—Foliated, scaly, granular, earthy	Metallic Dull Opaque	Dark steel g Iron black
PYROLUSITE MnO_2	Orthorhombic ? **C**—Often pseudomorphous after manganite **M**—Columnar, fibrous, acicular, often divergent; dendritic; powdery	Metallic Dull Opaque	Iron black Dark steel
Asphalt (Mineral pitch) C, H, O, etc.	Amorphous Solid, or thick liquid	Pitchy Resinous Dull Opaque	Black Brownish black

Hardness over 6

Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
Grayish Grayish green Pale brown White	C—Octahedral, indistinct F—Conchoidal Brittle	3.6 4.4	Common contact mineral in granular limestones; in igneous rocks, especially the more basic olivine-bearing types; also rounded grains in placers. With calcite, chondrodite, serpentine, brucite, olivine, corundum, graphite, pyroxenes.

Hardness 1 to 3

Dark lead gray; greenish on glazed porcelain (graphite, shiny black)	C—Basal, perfect Sectile, lamellæ are flexible	4.7 4.8	Marks paper. Soft and greasy like graphite, but heavier and lighter colored. In granite with cassiterite, wolframite; also in crystalline limestone.
Black, shiny Dark silver gray	C—Basal, perfect Sectile, lamellæ are flexible	1.9 2.3	Greasy feel; marks paper; darker than molybdenite and not as heavy. In crystalline limestone with garnet, spinel, pyroxenes, amphiboles; also in shale, gneiss, and mica schist.
Black Bluish black	C—Indistinct Brittle	4.7 4.8	Often soils fingers. Darker than stibnite. With psilomelane, manganite, hematite, limonite, barite.
Brownish black	C—None F—Conchoidal, conspicuous Brittle to flexible	1. 1.8	Bituminous odor when plastic. May be sticky. Independent deposits and impregnations in sand, shale, sandstone, limestone.

Streak—Black

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
WAD MnO_2, H_2O, etc.	Amorphous ? **M**—Earthy, sometimes with globular structure	Dull Submetallic Opaque	Brownish black Black
MELACONITE (Tenorite) CuO	Monoclinic **C**—Thin, scaly, pseudo-hexagonal (tenorite) **M**—Earthy, sooty (melaconite)	Metallic Dull Opaque	Iron blac Dark stee
Bituminous Coal (Soft coal) C, H, O, etc.	Amorphous **M**—Compact; may show stratification; lamellar, rarely fibrous	Pitchy Vitreous Dull Opaque	Black Brownish black
Anthracite Coal (Hard coal) C, principally	Amorphous **M**—Compact	Submetallic Vitreous Opaque	Iron blac Black
STIBNITE Sb_2S_3	Orthorhombic **C**—Prismatic, bent, twisted, common **M**—Fibrous, bladed, columnar, granular	Metallic Opaque	Dark lead Black
JAMESONITE $Pb_2Sb_2S_5$	Orthorhombic **C**—Acicular, long **M**—Fibrous, hair-like and felted, compact	Metallic Opaque	Dark lead Steel gra
Polybasite $(Ag,Cu)_9SbS_6$	Monoclinic **C**—Tabular, six-sided, with beveled edges **M**—Compact, disseminated	Metallic Opaque	Iron blac
Stephanite (Brittle silver ore) Ag_5SbS_4	Orthorhombic **C**—Tabular, thick prismatic **M**—Compact, disseminated	Metallic Opaque	Dark lead Iron blac

Hardness 1 to 3

Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
Black Brownish black	**F**—Earthy Brittle	3. 4.3	Soft varieties soil fingers. Apparently very light and floats on water, due to porosity. Usually adheres to tongue. With psilomelane, pyrolusite, siderite, limonite.
Black	**C**—Uneven **F**—Earthy Crystals, brittle	5.8 6.2	Coatings or crusts on copper minerals, especially native copper, chalcopyrite, bornite, chrysocolla. Earthy varieties soil fingers.
Black Brownish black	**F**—Cubical, conchoidal Brittle	1.1 1.5	Distinguished from other coals by conspicuous cubical fracture. Sometimes shows iridescence and distinct plant remains. With slate, pyrite, marcasite.
Black	**F**—Conchoidal, conspicuous Very brittle	1.3 1.7	Conchoidal fracture, luster, and absence of plant structure important. Often iridescent. With slate, pyrite, marcasite.
Dark lead gray Black	**C**—Brachypinacoidal, perfect, conspicuous, yielding long, shiny faces Slightly sectile	4.6 4.7	Tarnishes black, sometimes iridescent. In veins with quartz, sphalerite, galena, cinnabar, barite, gold.
Grayish black	**C**—Basal, rather conspicuous **F**—Uneven Brittle	5.5 5.8	Felted, fibrous masses often with feathery appearance. Heavier than stibnite and cleavage transverse to length. Sometimes with yellow coating. With bournonite, galena, sphalerite.
Black	**C**—Basal, not conspicuous **F**—Uneven Brittle	6. 6.2	Best known in crystals. Thin splinters are cherry red in transmitted light. With other silver minerals—stephanite, argentite, pyrargyrite.
Iron black	**C**—Imperfect **F**—Uneven Brittle	6.2 6.3	More brittle than argentite. In veins with other silver minerals; also barite, galena.

Streak—Black

Name Compositon	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Argentite (Silver glance) Ag_2S	Cubic **C**—Octahedral, cubical, often distorted **M**—Compact, arborescent; coatings	Metallic Opaque	Dark lead Black
GALENA (Galenite) PbS	Cubic **C**—Cubes alone, or with octahedron, well developed common **M**—Granular, cleavable aggregates, compact	Metallic Opaque	Dark lead
CHALCOCITE Cu_2S	Orthorhombic **C**—Tabular, pseudohexagonal, deeply striated **M**—Granular, compact, disseminated	Metallic Opaque	Dark lead often nished black, or gree
Bournonite (Cog-wheel ore) $PbCuSbS_3$	Orthorhombic **C**—Thick tabular; cog-wheel twins **M**—Compact, granular	Metallic Opaque	Dark stee Iron blac
Stromeyerite $(Cu,Ag)_2S$	Orthorhombic **C**—Tabular, rare **M**—Compact	Metallic Opaque	Dark lead
Enargite Cu_3AsS_4	Orthorhombic **C**—Prismatic, small, rare **M**—Compact, granular, columnar	Metallic Submetallic Opaque	Grayish Iron blac

Streak—Black

TETRAHEDRITE $Cu_8Sb_2S_7$	Cubic **C**—Tetrahedral, often highly modified **M**—Granular, compact	Metallic Opaque	Dark ste gray Iron bla

Hardness 1 to 3

Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
Dark lead gray, shiny	C—Indistinct F—Hackly Perfectly sectile	7.2 7.4	Cuts and takes impression like lead, hence easily distinguished from other soft, black minerals. With silver, cobalt, nickel ores—proustite, pyrargyrite, smaltite, niccolite.
Grayish black Dark lead gray	C—Cubic, perfect, very conspicuous Brittle	7.3 7.6	Characterized by cleavage and high specific gravity. Changes to cerussite, pyromorphite or anglesite. With sphalerite, pyrite, chalcopyrite, calcite, fluorite, barite.
Dark gray, shiny Black, shiny	C—Indistinct F—Conchoidal Rather brittle	5.5 5.8	More brittle than argentite. Often coated with malachite (green), azurite (blue). With chalcopyrite, bornite, tetrahedrite, galena.
Dark gray Black	C—Imperfect F—Uneven Brittle	5.7 5.9	Easily recognized by cross or cog-wheel appearance. With galena, sphalerite, tetrahedrite, siderite, stibnite, chalcocite.
Dark lead gray Black	C—Indistinct F—Conchoidal Slightly sectile	6.2 6.3	Resembles chalcocite but not as abundant. With copper and silver ores—argentite, proustite, chalcocite, tetrahedrite.
Grayish black	C—Prismatic, perfect, often conspicuous F—Uneven Brittle	4.4	In artificial light usually resembles sphalerite. In veins with other copper minerals—chalcopyrite, bornite, chalcocite, tennantite, famatinite.

Hardness over 3

Dark gray Black	C—Indistinct F—Uneven Brittle	4.3 5.4	Characteristic crystals, sometimes coated with chalcopyrite. With sphalerite, galena, bournonite, siderite, malachite.

Streak—Black

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Arsenic As	Hexagonal **C**—Rare **M**—Compact, scaly, fine granular; reniform or botryoidal	Metallic Opaque	Dark gra black white fresh ture
Uraninite (Pitchblende) UO_3, UO_2, PbO, etc.	Cubic **C**—Octahedral, rare **M**—Botryoidal, columnar, curved lamellar, granular; apparently amorphous	Pitch-like Submetallic Dull Opaque	Pitch blac Brownish black Greenish black
STANNITE Cu_2FeSnS_4	Tetragonal **C**—Small, rare **M**—Granular, disseminated	Metallic Opaque	Steel gray Iron blac Tarnishes
IRON (Native iron) Fe	Cubic **C**—Rare **M**—Disseminated grains, scales, lumps	Metallic Opaque	Iron gray Black
Ferberite $FeWO_4$	Monoclinic **C**—Wedge shaped, short prismatic, tabular **M**—Bladed, fan shaped; granular, compact	Submetallic Splendent Opaque	Iron blac Brownish black
WOLFRAMITE $(Fe,Mn)WO_4$	Monoclinic **C**—Thick, tabular, short columnar, often large **M**—Bladed, curved lamellar, granular, compact	Submetallic Metallic Opaque	Dark gra Brownish black Iron blac
Psilomelane MnO_2, BaO, H_2O, etc.	Amorphous? **M**—Botryoidal, reniform, stalactitic; smooth surface	Metallic Dull Opaque	Iron blac Bluish bl Dark gra
Ilmenite (Menaccanite) $FeTiO_3$	Hexagonal **C**—Thick tabular, rhombohedral **M**—Thin plates, granular, compact; disseminated; pebbles, sand	Metallic Submetallic Opaque	Iron blac Brownish black

Hardness over 3

Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
Dark gray Black	**C**—Basal, not conspicuous **F**—Uneven, granular Brittle	5.6 5.8	Often breaks in concentric or onion-like layers. Color and streak darken on exposure. With silver, cobalt, nickel ores—proustite, smaltite, chloanthite.
Brownish black Grayish black	**F**—Conchoidal, uneven Brittle	4.8 9.7	Pitch-like appearance and fracture important. Fresh material is hard and heavy. With ores of lead, silver, bismuth; pyrite, thorite, orthite, fergusonite.
Black	**C**—Indistinct **F**—Uneven Brittle	4.3 4.5	Often yellowish from admixture of chalcopyrite. With cassiterite, wolframite; in tin ore deposits.
Iron gray, shiny	**C**—Cubical, not conspicuous **F**—Hackly Malleable	7.3 7.8	Alloyed with nickel. Strongly magnetic. In meteorites or basic igneous rocks (basalts). With troilite, pyrrhotite, olivine, graphite.
Brownish black	**C**—Clinopinacoidal, perfect **F**—Uneven Brittle	7.1 7.5	In granites and pegmatites. With quartz, chalcopyrite, galena, scheelite.
Brownish black Black	**C**—Clinopinacoidal, perfect, conspicuous **F**—Uneven Brittle	7.1 7.5	Structure, cleavage, and specific gravity important. Powder may be slightly magnetic. With cassiterite, quartz, mica, fluorite, apatite, scheelite, molybdenite, huebnerite.
Black Brownish black	**F**—Conchoidal, uneven Brittle	3.7 4.7	Often with fine, sooty coating of pyrosulite. With other manganese minerals; limonite, barite.
Black Brownish black	**C**—None, partings may be noted **F**—Conchoidal Brittle	4.5 5.5	Sometimes slightly magnetic but not as strongly as magnetite. With hematite, magnetite, apatite, serpentine, titanite, rutile. Common in black sand.

Streak—Black

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Ilvaite $CaFe_2(Fe.OH)(SiO_4)_2$	Orthorhombic **C**—Columnar, acicular, vertically striated **M**—Compact with radial fibrous structure, granular	Submetallic Opaque	Black Greenish black Brownish black
MAGNETITE $Fe(FeO_2)_2$	Cubic **C**—Octahedrons, dodecahedrons, common **M**—Compact, granular, lamellar, disseminated, sand	Metallic Submetallic Dull Opaque	Iron blac
FRANKLINITE $(Fe,Mn,Zn)(FeO_2)_2$	Cubic **C**—Octahedrons, alone or with dodecahedron; edges often rounded **M**—Compact, granular, rounded grains	Metallic Dull Opaque	Iron blac
Braunite $MnMnO_3$	Tetragonal **C**—Apparently octahedrons, small **M**—Drusy crusts, granular aggregates	Metallic Greasy Opaque	Black Dark bro ish blac
COLUMBITE (Tantalite) $(Fe,Mn)[(Nb,Ta)O_3]_2$	Orthorhombic **C**—Short prismatic, tabular **M**—Compact, disseminated	Submetallic Greasy Dull Opaque	Iron blac Brownish black
CORUNDUM, variety *Emery* Al_2O_3, with Fe_3O_4, Fe_2O_3, SiO_2	Hexagonal Always massive, fine to coarse granular	Metallic Dull Opaque	Dark gra Black

Hardness over 3

Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
Black Brownish black Greenish black	C—Pinacoidal F—Uneven Brittle	3.9 4.1	Often covered with yellowish alteration product which reduces hardness. With dolomite, pyroxenes, iron ores.
Black	C—Indistinct, octahedral parting F—Conchoidal, uneven Brittle	4.9 5.2	Very strongly magnetic. Crystals usually perfect and with bright surfaces. Independent deposits; disseminated; black sands. With chlorite, hornblende, pyroxene, feldspar, quartz, pyrite, chalcopyrite, epidote.
Black Brownish black	C—Octahedral, indistinct F—Conchoidal Brittle	5. 5.2	Powder may be slightly magnetic. Distinguished by associates—willemite (yellow or green), zincite (red), rhodonite (flesh red), calcite.
Black Brownish black	C—Pyramidal F—Uneven Brittle	4.7 4.9	Small, untwinned octahedral crystals. With manganese minerals —pyrolusite, psilomelane, hausmannite; magnetite, barite, hematite.
Black Brownish black Grayish black	C—Pinacoidal, not conspicuous F—Conchoidal, uneven Brittle	5.4 6.4	Fracture surface sometimes iridescent. With beryl, tourmaline, spodumene, cryolite. Tantalum predominates in *tantalite* and specific gravity may be as high as 9.
Black Brownish black	C—Indistinct F—Uneven Brittle to tough	3.7 4.3	Corundum mixed with magnetite, hematite, quartz. Resembles iron ore and powder may be magnetic. Properties vary with composition. With mica, amphiboles, chlorite, spinel; in crystalline limestone, schist, peridotite.

Streak—Metallic white or steel gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
MERCURY (Quicksilver) Hg	Cubic, at—39° C., liquid at ordinary temperatures	Metallic Opaque	Tin white
Sylvanite $(Au,Ag)Te_2$	Monoclinic **C**—Rare **M**—Branching arborescent forms, simulating written characters; bladed, columnar, granular	Metallic Opaque	Silver whi Steel gra times brassy
Bismuth Bi	Hexagonal **C**—Rare **M**—Reticulated, arborescent, platy	Metallic Opaque	Silver whi with re tinge
SILVER Ag	Cubic **C**—Small, often distorted **M**—Grains, scales, plates, twisted hair- or wire-like forms, lumps	Metallic Opaque	Silver wh tarnishi yellow, brown, black

Streak—Metallic white or steel gray

Amalgam (Silver amalgam) (Ag,Hg)	Cubic **C**—Rare **M**—Plates, coatings, embedded grains	Metallic Opaque	Silver wh
ANTIMONY Sb	Hexagonal **C**—Rare **M**—Compact, granular, lamellar	Metallic Opaque	Tin white Light st gray
Dyscrasite Ag_3Sb	Orthorhombic **C**—Columnar, tabular, rare **M**—Compact, granular, nodular, coatings	Metallic Opaque	Silver wh tarnish yellow black

Hardness 1 to 3

rd-ss	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
			13.5 13.6	As small drops or globules on cinnabar, calomel, shale, schist.
5	Gray	**C**—Clinopinacoidal, perfect, usually conspicuous **F**—Uneven Brittle	7.9 8.3	Resembles ancient script, hence *graphic tellurium*. With gold, calaverite, sphalerite, pyrite, tetrahedrite.
5	Lead gray, shiny	**C**—Basal, perfect, usually conspicuous Sectile	9.7 9.8	Often shows brassy tarnish colors. With silver, cobalt, nickel, tin ores—smaltite, niccolite, chloanthite, cassiterite; wolframite.
5	Silver white, shiny Light lead gray, shiny	**C**—None **F**—Hackly Malleable, ductile	10. 12.	Color and streak darken on exposure. With silver, lead, arsenic, cobalt, nickel ores—argentite, pyrargyrite, proustite, smaltite, galena; fluorite, calcite, barite.

Hardness over 3

	Silver white	**C**—None **F**—Conchoidal Brittle to malleable	13.7 14.1	With native mercury, cinnabar, and silver minerals.
	Tin white Lead gray	**C**—Basal, perfect, usually conspicuous **F**—Uneven Brittle	6.6 6.7	Does not tarnish readily. With silver, arsenic, and other antimony minerals—kermesite, stibnite, smaltite, allemontite. Sometimes coated with white oxide of antimony.
5	Gray, shiny	**C**—Domatic **F**—Uneven Sectile	9.4 10.	With galena, arsenic, pyrargyrite, native silver, smaltite.

Streak—Metallic white or steel gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Platinum Pt	Cubic **C**—Small, rare **M**—Scales grains, nuggets	Metallic Opaque	Tin white Steel gray
IRIDOSMIUM (Os,Ir)	Hexagonal **C**—Thin tabular **M**—Scales, flattened grains	Metallic Opaque	Tin white Light steel gray

Streak—Black

Molybdenite MoS_2	Hexagonal **C**—Tabular, rare **M**—Disseminated grains, scales, foliated	Metallic Opaque	Bluish lead gray
BISMUTHINITE Bi_2S_3	Orthorhombic **C**—Acicular, rare **M**—Granular, foliated, fibrous	Metallic Opaque	Lead gray Tin white
STIBNITE Sb_2S_3	Orthorhombic **C**—Prismatic, bent, twisted, common **M**—Fibrous, bladed, columnar, granular, compact	Metallic Opaque	Light lead gray
JAMESONITE $Pb_2Sb_2S_5$	Orthorhombic **C**—Long, acicular **M**—Fibrous, hair-like, felted, compact	Metallic Opaque	Steel gray Lead gray
GALENA (Galenite) PbS	Cubic **C**—Cubes, alone or with octahedron, common, well developed **M**—Granular, cleavable aggregates	Metallic Opaque	Lead gray

Hardness over 3

rd-ess	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
.	Light steel gray, shiny	C—None F—Hackly Malleable, ductile	14. 19.	Heavier than silver and does not tarnish. May be magnetic if much iron is present. With chromite, magnetite, gold, iridosmium.
. .	Grayish	C—Basal, perfect F—Uneven Slightly malleable	20. 21.2	Distinguished from platinum by greater hardness. In placers with platinum, gold, chromite.

Hardness 1 to 3

. 5	Dark lead gray, greenish on glazed porcelain (graphite, shiny black)	C—Basal, perfect Sectile, lamellæ flexible	4.7 4.8	Marks paper. Soft and greasy like graphite but heavier and lighter colored. In granite with cassiterite, wolframite; in crystalline limestone.
.	Dark gray Black	C—Brachypinacoidal, perfect, rather conspicuous Slightly sectile	6.4 6.6	Heavier and lighter in color than stibnite. With cassiterite, bismuth, chalcopyrite, gersdorffite, wolframite.
. 5	Dark lead gray Black	C—Brachypinacoidal, perfect, conspicuous, yielding long shiny faces Slightly sectile	4.6 4.7	Differs from galena in cleavage and specific gravity. Tarnishes black, sometimes iridescent. In veins with quartz, sphalerite, galena, cinnabar, barite, gold.
. 5	Grayish black	C—Basal, rather conspicuous F—Uneven Brittle	5.5 5.8	Felted fibrous masses, often with feathery appearance. Heavier than stibnite and cleavage transverse. With bournonite, galena, sphalerite.
5	Dark lead gray Grayish black	C—Cubic, perfect, very conspicuous Brittle	7.3 7.6	Characterized by excellent cleavage and high specific gravity. Changes to cerussite, pyromorphite, or anglesite. With sphalerite, pyrite, chalcopyrite, calcite, fluorite, barite.

Streak—Black

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Arsenic As	Hexagonal **C**—Rare **M**—Compact, scaly, fine grained, reniform, botryoidal	Metallic Opaque	Tin white, fresh fra ture
Domeykite Cu_3As	**C**—Unknown **M**—Compact, reniform, botryoidal	Metallic Opaque	Tin white, w yellow a variegate tarnish
Löllingite $FeAs_2$	Orthorhombic **C**—Rare **M**—Granular, disseminated, compact	Metallic Opaque	Silver white Steel gray
Linnæite $(Ni,Co)_3S_4$	Cubic **C**—Octahedral **M**—Granular, compact	Metallic Opaque	Steel gray, times wi reddish ti
Cobaltite CoAsS	Cubic **C**—Cubes, pyritohedrons, small, well developed **M**—Granular, compact	Metallic Opaque	Silver whit Steel gray, times wi reddish tinge
Smaltite $CoAs_2$	Cubic **C**—Rare **M**—Granular, compact	Metallic Opaque	Tin white Light steel gray
Chloanthite $NiAs_2$	Cubic **C**—Rare **M**—Granular, compact	Metallic Opaque	Tin white Light steel gray

Hardness over 3

rd-ss	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
	Lead gray Grayish black	C—Basal,not conspicuous F—Uneven, granular Brittle	5.6 5.8	Often breaks in concentric or onion-like layers. Color and streak darken on exposure. With silver, cobalt, nickel ores—proustite, smaltite, chloanthite.
5	Grayish black	C—None F—Uneven Brittle	7.2 7.5	Tarnishes readily and then resembles chalcopyrite, but much heavier. With copper, silver, and niccolite. *Mohawkite*, nickeliferous variety.
5	Grayish black	C—Basal, not conspicuous F—Uneven Brittle	7.1 7.4	Tarnishes gray. Not as common as arsenopyrite. Frequently in serpentine. With siderite, cassiterite, arsenopyrite, hornblende.
5	Grayish black	C—Indistinct F—Uneven Brittle	4.8 5.8	Tarnishes copper red. With chalcopyrite, pyrrhotite, siderite; cobalt and nickel minerals.
5	Dark grayish black	C—Cubic, not conspicuous F—Uneven Brittle	6. 6.4	May show red tarnish. Often with pink coating of erythrite (cobalt bloom). With native silver, smaltite, niccolite, pyrrhotite, chalcopyrite.
5	Grayish black	C—Indistinct F—Uneven Brittle	6.4 6.6	May have dull tarnish and pink coating of erythrite. With niccolite, cobaltite, native bismuth and silver, proustite, barite, fluorite, calcite.
5	Grayish black	C—Indistinct F—Uneven Brittle	6.4 6.6	Tarnishes dull and often coated with green annabergite (nickel bloom). Resembles smaltite but not as abundant. With niccolite, cobaltite, proustite, native silver and bismuth, calcite.

Streak—Black

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
ARSENOPYRITE FeAsS	Orthorhombic **C**—Prismatic, common **M**—Compact, granular, columnar, radial	Metallic Opaque	Tin white Light steel gray, tarnishes ye low
MARCASITE (White iron pyrites) FeS_2	Orthorhombic **C**—Tabular, often twinned, resembling cock's combs **M**—Compact, stalactitic, globular, radiated	Metallic Opaque	Steel gray Pale brass y low, m brassy on posure

Hardness over 3

ld-s	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
5	Dark grayish black	C—Prismatic, not conspicuous F—Uneven Brittle	5.9 6.2	Whiter than marcasite. More common than smaltite or chloanthite. With chalcopyrite, pyrite, sphalerite, cassiterite, smaltite, native gold and silver, serpentine
5	Dark greenish black	C—Indistinct F—Uneven Brittle	4.6 4.8	Alters to limonite, melanterite. With other sulphides—galena, sphalerite, chalcopyrite, pyrite; calcite, dolomite.

Streak—Gray, brown, or yellow

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
LIMONITE, varieties *Yellow ocher* $Fe_2O_3.nH_2O$ *Bog iron ore*	**M**—Earthy, porous, clay-like	Earthy Dull Opaque	Yellow Brownish yellow
Calaverite $AuTe_2$	Monoclinic **C**—Rare **M**—Compact	Metallic Opaque	Light br yellow
GOLD Au	Cubic **C**—Small, often distorted **M**—Grains, scales, nuggets, dust	Metallic Opaque	Golden ye Brassy ye Light yell
SPHALERITE ZnS	Cubic **C**—Tetrahedral, common **M**—Compact, fine or coarse grained, cleavable aggregates	Resinous Submetallic Translucent to opaque	Honey yel Brownish low Reddish low
***Goethite** FeO.OH	Orthorhombic **C**—Small, thin tabular, needle-like; parallelly grouped or in scaly, fibrous velvety crusts **M**—Reniform, stalactitic	Submetallic Translucent to opaque	Yellow Brownish low
Orangite (Thorite) $ThSiO_4$	Tetragonal **C**—Square prisms with bipyramids **M**—Compact, disseminated	Resinous Vitreous Transparent to translucent	Orange ye Brownish low

* Uncommon color.

Hardness 1 to 6

Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
Yellowish brown	C—None F—Earthy Brittle	3.4 4.	*Yellow ocher*, earthy, may have greasy feel, when impure gritty; *bog iron ore*, porous.
Gray	C—None F—Uneven Brittle	9.	With gold, sylvanite, petzite, tetrahedrite, pyrite.
Golden yellow	C—None F—Hackly Malleable, ductile	15.6 19.3	Does not tarnish. Differs from other soft, yellow minerals in streak, specific gravity, and tenacity. Frequently in quartz veins, placers. With pyrite, galena, sphalerite, arsenopyrite, stibnite, chalcopyrite.
Pale yellow	C—Dodecahedral, perfect, conspicuous F—Conchoidal Brittle	3.9 4.2	Color and streak vary with impurities. Extensively in limestone. With galena, chalcopyrite, pyrite, barite, fluorite, siderite, rhodochrosite, smithsonite.
Yellow Yellowish brown	C—Brachypinacoidal, perfect F—Uneven, splintery Brittle	4. 4.4	Usually with other iron ores; in cavities with hematitie or limonite.
Light orange Dark brown	C—Prismatic, not conspicuous F—Conchoidal Brittle	4.4 5.4	Yellow orangite is sometimes surrounded by dark brown to black thorite; latter is thought to be decomposed orangite.

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Streak—Gray, brown, or yellow			
*Zincite ZnO	Hexagonal C—Hemimorphic, rare M—Compact, granular, foliated	Subadamantine Vitreous Translucent to opaque	Orange ye Reddish y low
Streak—Black			
Millerite NiS	Hexagonal C—Needle-like, radiating groups, hair tufts M—Fibrous, compact	Metallic Opaque	Brass yel Bronze ye
Domeykite Cu_3As	C—Unknown M—Compact, reniform, botryoidal	Metallic Opaque	Yellow a variega colors exposu
CHALCOPYRITE $CuFeS_2$	Tetragonal C—Bisphenoids, resembling tetrahedrons, common M—Compact	Metallic Opaque	Brass yel Golden ye
Pentlandite (Fe,Ni)S	Cubic C—Rare M—Compact, granular	Metallic Opaque	Light b yellow
MARCASITE (White iron pyrites) FeS_2	Orthorhombic C—Tabular, often twinned, resembling cock's combs M—Compact, stalactitic, globular, radiated	Metallic Opaque	Pale bras low, brassy posure

* Uncommon color.

Hardness 1 to 6

Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
Orange yellow Reddish yellow	C—Basal, perfect, usually conspicuous F—Uneven Brittle	5.4 5.7	Distinguished by associates—calcite, franklinite (black), willemite (yellow to green), rhodonite (flesh red). On exposure becomes coated with the white carbonate.

Hardness over 3

Dark greenish black	C—Basal F—Uneven Brittle	5.3 5.9	Often in cavities in limestone or hematite. With pyrrhotite, chalcopyrite, chloanthite, barite, fluorite.
Grayish black	C—None F—Uneven Brittle	7.2 7.5	When tarnished resembles chalcopyrite, but much heavier. Tin white on fresh fracture. With copper, silver, and niccolite. *Mohawkite*, nickeliferous variety.
Greenish black	C—Indistinct F—Uneven Brittle	4.1 4.3	Softer, and deeper yellow in color than pyrite. Frequently with iridescent tarnish. With pyrite, bornite, galena, sphalerite, tetrahedrite, chalcocite.
Black	C—Octahedral, often conspicuous F—Uneven Brittle	4.6 5.1	Non-magnetic. With chalcopyrite, pyrrhotite.
Dark greenish black Brownish black	C—Indistinct F—Uneven Brittle	4.6 4.8	Distinguished from pyrite by crystallization and lighter color on fresh fracture. Alters more readily than pyrite, forming limonite, melanterite. Occurrence same as for pyrite, but not as abundant.

Streak—Black

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
PYRITE (Iron pyrites, fool's gold) FeS_2	Cubic **C**—Cubes, octahedrons, pyritohedrons, very common, often striated **M**—Compact, fine granular; botryoidal, stalactitic	Metallic Opaque	Brass yel Golden y with gated nish

Hardness over 3

Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
Greenish black Brownish black	C—Indistinct F—Uneven Brittle	4.9 5.2	Harder than chalcopyrite. Alters to limonite, copiapite. Widely distributed in all types of rocks. With other sulphides—galena, sphalerite, chalcopyrite.

Streak—Gray, red, or yellow

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Bismuth Bi	Hexagonal **C**—Rare **M**—Reticulated, arborescent, platy	Metallic Opaque	Light cop red
Calaverite $AuTe_2$	Monoclinic **C**—Rare **M**—Compact	Metallic Opaque	Light b yellow
COPPER Cu	Cubic **C**—Cubes, octahedrons, tetrahexahedrons **M**—Scales, plates, lumps, arborescent aggregates	Metallic Opaque	Copper r tarnish readily blue, black
GOLD Au	Cubic **C**—Small, distorted, rare **M**—Grains, scales, dust, nuggets	Metallic Opaque	Golden y Brassy y Light yel

Streak—Black

BORNITE Cu_5FeS_4	Cubic **C**—Rare **M**—Compact, granular	Metallic Opaque	Bronze b Copper r fresh ture
Millerite NiS	Hexagonal **C**—Needle-like, often in radial groups, hair-tufts **M**—Fibrous, compact	Metallic Opaque	Brass yel Bronze
Domeykite Cu_3As	**C**—Unknown **M**—Compact, reniform, botryoidal	Metallic Opaque	Yellow Variegat exposu

Hardness 1 to 3

Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
Lead gray, shiny	C—Basal, perfect, usually conspicuous Sectile	9.7 9.8	Often shows brassy tarnish. Frequently with silver, cobalt, nickel, tin ores—smaltite, niccolite, chloanthite, cassiterite; wolframite.
Gray	C—None F—Uneven Brittle	9.	With gold, sylvanite, petzite tetrahedrite, pyrite.
Copper red, shiny	C—None F—Hackly Ductile, malleable	8.5 9.	Cementing material in conglomerate or filling cavities in trap. With cuprite, malachite, azurite, native silver, tenorite, epidote, prehnite, datolite, zeolites, quartz, calcite.
Golden yellow	C—None F—Hackly Malleable, ductile	15.6 19.3	Does not tarnish. Differs from other soft yellow minerals in streak, specific gravity, and tenacity. Frequently in quartz veins; placers. With pyrite, galena, sphalerite, arsenopyrite, stibnite, chalcopyrite.

Hardness over 3

Grayish black	C—Indistinct F—Uneven Brittle	4.9 5.2	Usually with peacock tarnish colors (purple copper ore). With chalcopyrite, chalcocite, malachite, cassiterite, siderite.
Dark greenish black	C—Basal F—Uneven Brittle	5.3 5.9	In cavities in limestones, hematite, dolomite. With pyrrhotite, chalcopyrite, chloanthite, barite, fluorite.
Grayish black	C—None F—Uneven Brittle	7.2 7.5	When tarnished resembles chalcopyrite but much heavier. Tin white on fresh fracture. With copper, silver, and niccolite. *Mohawkite*, nickeliferous variety.

Streak—Black

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
CHALCOPYRITE $CuFeS_2$	Tetragonal **C**—Bisphenoids, resembling tetrahedrons, common **M**—Compact, granular	Metallic Opaque	Brass ye Golden ye
Pentlandite (Fe,Ni)S	Cubic **C**—Extremely rare **M**—Compact, granular	Metallic Opaque	Light br yellow
PYRRHOTITE FeS	Hexagonal **C**—Tabular, rare **M**—Compact, granular	Metallic Opaque	Bronze y Bronze b
Niccolite NiAs	Hexagonal **C**—Rare **M**—Compact, disseminated	Metallic Opaque	Light co red
MARCASITE (White iron pyrites) FeS_2	Orthorhombic **C**—Tabular, often twinned resembling cock's combs **M**—Compact, stalactitic, globular, radiated	Metallic Opaque	Steel gra Pale bras low, brassy posure
PYRITE (Iron pyrites, fool's gold) FeS_2	Cubic **C**—Cubes, octahedrons, pyritohedrons, very common, often striated **M**—Compact, fine granular; botryoidal, stalactitic	Metallic Opaque	Brass y Golden y with gated t

Hardness over 3

d- s	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
5	Greenish black	C—Indistinct F—Uneven Brittle	4.1 4.3	Softer, and deeper yellow in color than pyrite. Frequently with iridescent tarnish. With pyrite, bornite, galena, sphalerite, tetrahedrite, chalcocite.
5	Black	C—Octahedral, often conspicuous F—Uneven Brittle	4.6 5.1	Non-magnetic. With chalcopyrite, pyrrhotite.
5 5	Dark grayish black	C—Basal, not conspicuous F—Uneven Brittle	4.5 4.6	Powder frequently attracted by magnet. Subject to dark brown tarnish. In basic igneous rocks. With chalcopyrite, pyrite, pentlandite, galena.
5	Dark brownish black	C—Indistinct F—Uneven Brittle	7.3 7.7	Often with green coating of annabergite (nickel bloom). With cobalt, nickel, silver minerals—smaltite, proustite, chloanthite, native silver; native bismuth and arsenic; calcite.
5	Dark greenish black	C—Indistinct F—Uneven Brittle	4.6 4.8	Distinguished from pyrite by crystallization and lighter color on fresh fracture. Alters more readily than pyrite, forming limonite, melanterite. Occurrence same as for pyrite, but not as abundant.
5	Greenish black Brownish black	C—Indistinct F—Uneven Brittle	4.9 5.2	Alters to limonite, copiapite. Widely distributed in all types of rocks. With other sulphides—galena, sphalerite, chalcopyrite.

Streak—White, gray, green, red, brown, or yellow

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
WAD MnO_2, H_2O, etc.	Amorphous ? **M**—Earthy, sometimes with globular structure	Dull Submetallic Opaque	Brown Blackish brown
LIMONITE, varieties *Brown ocher* *Bog iron ore* *Brown clay ironstone* $Fe_2O_3.nH_2O$	**C**—Unknown **M**—Compact, earthy, porous, pisolitic, oolitic	Dull Earthy Opaque	Yellowish brown Dark brow
HEMATITE, varieties *Red ocher* *Oolitic* *Fossiliferous* Fe_2O_3	Hexagonal **M**—Fine granular, earthy, scaly, oolitic, fossiliferous	Dull Earthy Opaque	Brownish Cherry red
CINNABAR HgS	Hexagonal **C**—Rhombohedral, thick tabular, small, rare **M**—Fine granular, fibrous, disseminated, earthy coating	Adamantine Dull Transparent to opaque	Scarlet red Brownish
Proustite Ag_3AsS_3	Hexagonal **C**—Small, complex, rare **M**—Disseminated, crusts, bands	Adamantine Dull Transparent to translucent	Scarlet Vermilion
Pyrargyrite Ag_3SbS_3	Hexagonal **C**—Small, complex, rare **M**—Disseminated, crusts, bands	Adamantine Metallic Transparent to opaque	Dark re
COPPER Cu	Cubic **C**—Cubes, octahedrons, tetrahexahedrons **M**—Scales, plates, lumps, arborescent aggregates	Metallic Opaque	Copper r tarnishi readily red, bl green, b

Hardness 1 to 3

rd-ss	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
	Dark brown Blackish brown	C—None F—Earthy Brittle	3. 4.3	Very soft varieties soil fingers. Apparently very light and floats on water, due to porosity. Usually adheres to tongue. With psilomelane, pyrolusite, siderite, limonite.
	Yellowish brown	C—None F—Earthy Brittle	3.4 4.	*Brown ocher*, earthy, may soil fingers; *bog iron ore*, porous; *brown clay ironstone*, massive or concretionary, impure from clay, sand.
	Cherry red Reddish brown	C—None F—Earthy Brittle	4.9 5.3	*Red ocher*, earthy; *oolitic*, fish-egg structure; *fossiliferous*, replacement of shells.
5	Scarlet Reddish brown	C—Prismatic, not conspicuous F—Uneven Brittle to sectile	8. 8.2	Color, streak, high specific gravity important; the latter often reduced by gangue. Disseminated in silicious rocks, with native mercury, pyrite, marcasite, realgar, stibnite.
5	Scarlet Aurora red	C—Indistinct F—Conchoidal Brittle	5.5 5.6	Termed light ruby silver ore. Distinguished from cinnabar by associates. With pyrargyrite, in veins with other silver minerals and galena.
5	Cherry red Purplish red	C—Indistinct F—Conchoidal Brittle	5.8	Frequently as gray or dark red bands, dark ruby silver ore. With proustite, in veins with other silver minerals and galena.
5	Copper red, shiny	C—None F—Hackly Ductile, malleable	8.5 9.	Cementing material in conglomerate, or filling cavities in trap. With cuprite, malachite, azurite, native silver, tenorite, epidote, prehnite, datolite, zeolites, quartz, calcite.

Streak—White, gray, green, red, brown, or yellow

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
LIMONITE, varieties *Compact* $Fe_2O_3.nH_2O$ *Bog iron ore* *Brown clay ironstone*	**C**—Always pseudomorphs, commonly after pyrite, marcasite, siderite **M**—Compact, stalactitic, botryoidal, nodular; often radial fibrous structure; porous	Metallic Dull Opaque	Yellowish brown Dark brow
Uraninite (Pitchblende) UO_3, UO_2, PbO, etc.	Cubic **C**—Octahedral, rare **M**—Botryoidal, columnar, curved lamellar, granular; apparently amorphous	Submetallic Dull Opaque	Brown Blackish brown
HEMATITE, varieties *Argillaceous* Fe_2O_3 *Compact*	Hexagonal **M**—Compact, granular, columnar, radiated; reniform, botryoidal	Submetallic Dull Opaque	Brownish r Dark red Blackish re
SIDERITE $FeCO_3$	Hexagonal **C**—Rhombohedral, curved or saddle-shaped, common **M**—Cleavable, granular, compact, botryoidal	Dull Vitreous Translucent to opaque	Dark brow Reddish brown
SPHALERITE ZnS	Cubic **C**—Tetrahedral, common **M**—Cleavable, fine and coarse grained aggregates, compact	Submetallic Resinous Opaque to translucent	Brown Yellowish brown Reddish brown
CUPRITE Cu_2O	Cubic **C**—Octahedrons, dodecahedrons, alone or in combination **M**—Compact, granular, earthy acicular	Adamantine Dull Translucent to opaque	Cochineal red Brick red Dark red

Hardness 3 to 6

d-s	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
5	Yellowish brown	**F**—Conchoidal, uneven, earthy Brittle	3.4 4.	Often with black, varnish-like surface, passing into soft, yellow ocherous variety. *Compact limonite*, massive, with fibrous structure, rather pure; *brown clay ironstone*, massive or concretionary, impure from clay, sand; *bog iron ore*, porous.
5	Dark brown Olive green Grayish	**F**—Conchoidal, uneven Brittle	4.8 9.7	Structure and fracture important. Fresh material is hard and heavy. With ores of lead, silver, bismuth; also orthite, thorite, fergusonite.
	Cherry red Reddish brown	**C**—None, parting sometimes noted **F**—Uneven, splintery Brittle	4.9 5.3	*Argillaceous hematite*, impure from clay, sand, jasper; *compact hematite*, usually quite pure.
	Yellowish brown Pale yellow	**C**—Rhombohedral, perfect, conspicuous **F**—Conchoidal Brittle	3.7 3.9	Curved crystals and cleavage characteristic. In beds and concretions in limestone and shale. With pyrite, chalcopyrite, galena, tetrahedrite, cryolite.
	Light brown Pale yellow	**C**—Dodecahedral, perfect, conspicuous **F**—Conchoidal Brittle	3.9 4.2	Color and streak vary with impurities. Extensively in limestone. With galena, chalcopyrite, pyrite, barite, fluorite, siderite, rhodochrosite, smithsonite.
	Brownish red Dirty brown	**C**—Indistinct **F**—Uneven Brittle	5.7 6.1	Characterized by associates, usually with copper minerals—malachite (green), azurite (blue), chalcocite and tenorite (black), chalcopyrite (yellow), native copper. Slender crystal aggregates (*chalcotrichite*).

Streak—White, gray, green, red, brown, or yellow

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Zincite ZnO	Hexagonal **C**—Hemimorphic, rare **M**—Compact, granular, foliated	Subadamantine Vitreous Translucent to opaque	Dark red Blood red
Goethite FeO.OH	Orthorhombic **C**—Small, thin, tabular, needle-like; parallelly grouped **M**—Reniform, stalactitic	Submetallic Translucent to opaque	Reddish b Dark brov Red
Huebnerite $MnWO_4$	Monoclinic **C**—Long fibrous, bladed, stalky, often divergent, without good terminations **M**—Compact, lamellar, granular	Submetallic Resinous Opaque to translucent	Reddish b Brown
WOLFRAMITE $(Fe,Mn)WO_4$	Monoclinic **C**—Thick, tabular, short columnar, often large **M**—Bladed, curved lamellar, granular, compact	Submetallic Opaque	Reddish b Dark brov
Ferberite $FeWO_4$	Monoclinic **C**—Wedge shaped, short prismatic, tabular **M**—Bladed, fan shaped; granular, compact	Submetallic Opaque	Brown Blackish brown
***Orthite** (Allanite) $Ca_2(Al,Ce,Fe)_2(Al.OH)(SiO_4)_3$	Monoclinic **C**—Tabular, rare **M**—Compact, granular, bladed, disseminated grains	Submetallic Resinous Opaque to translucent	Dark brov Blackish brown Grayish b
Anatase (Octahedrite) TiO_2	Tetragonal **C**—Pyramidal, tabular, rarely prismatic	Metallic Adamantine Opaque to translucent	Reddish b Yellowish brown Blackish b

* Uncommon color.

Hardness 3 to 6

Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
Reddish yellow Orange yellow	C—Basal, perfect, usually conspicuous F—Uneven Brittle	5.4 5.7	Distinguished by associates—calcite, franklinite (black), willemite (yellow to green), rhodonite (flesh red). On exposure coated with white carbonate.
Yellow Yellowish brown	C—Brachypinacoidal, perfect F—Uneven, splintery Brittle	4. 4.4	Usually with other iron ores; in cavities in hematite or limonite. Crystals and cleavage distinguish it from limonite. Often as scaly, fibrous, velvety crusts.
Yellowish brown Greenish gray	C—Clinopinacoidal, perfect, conspicuous Brittle	6.7 7.3	Structure, cleavage, specific gravity important. In quartz veins. With fluorite, pyrite, scheelite, wolframite, galena, tetrahedrite.
Dark red brown	C—Clinopinacoidal, perfect, conspicuous F—Uneven Brittle	7.1 7.5	Distinguished from huebnerite by streak. Powder may be slightly magnetic. With cassiterite, quartz, mica, fluorite, apatite, scheelite, molybdenite, huebnerite.
Brown Dark brown	C—Clinopinacoidal, perfect F—Uneven Brittle	7.5	In granites and pegmatities. With quartz, chalcopyrite, galena, scheelite.
Grayish Brownish gray Pale brown	C—Pinacoidal, indistinct F—Uneven, conchoidal Brittle	3. 4.	Often coated with yellowish or brownish alteration product. Disseminated in acid igneous rocks; limestone. With magnetite, epidote, quartz, feldspars.
Gray White	C—Pyramidal, basal, perfect F—Sub-conchoidal Brittle	3.8 3.9	Crystals often resemble elongated octahedrons. With brookite, rutile, ilmenite, adularia, titanite, gold.

Streak—White, gray, green, red, brown, or yellow

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Brookite TiO_2	Orthorhombic **C**—Pyramidal, (often with hexagonal habit), prismatic, tabular	Metallic Adamantine Opaque to translucent	Blackish brown Blackish red
Perovskite $CaTiO_3$	Pseudocubic **C**—Apparently cubes, highly modified, often striated **M**—Reniform aggregates, rounded grains	Metallic Adamantine Opaque to transparent	Reddish b Blackish brown

Streak—White, gray, green, red, brown, or yellow

Gadolinite $Fe[Be(Y.O)SiO_4]_2$	Monoclinic **C**—Prismatic, rough, rare **M**—Compact, disseminated	Submetallic Translucent to opaque	Brown
RUTILE TiO_2 or $TiTiO_4$	Tetragonal **C**—Prismatic, vertically striated; twinned, yielding knee-shaped or rosette forms **M**—Compact, disseminated	Metallic Adamantine Opaque to transparent	Reddish b Dark red
CASSITERITE, varieties *Ordinary* *Wood tin* *Stream tin* SnO_2 or $SnSnO_4$	Tetragonal **C**—Thick prismatic, knee-shaped twins, common **M**—Compact; reniform, botryoidal, rounded pebbles, often with internal, radial fibrous structure, *wood tin*	Adamantine Resinous Dull Translucent to opaque	Reddish b Yellowish brown Dark bro

Hardness 3 to 6

Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
Pale yellowish brown Gray	C—Indistinct F—Uneven Brittle	3.8 4.1	Crystals may be striated; not twinned like rutile. With rutile, anatase, titanite, adularia, nephelite.
White Grayish	C—Cubical, fairly distinct F—Uneven Brittle	4. 4.1	With chlorite, magnetite, serpentine, limestone.

Hardness over 6

Greenish gray	C—None F—Conchoidal, splintery Brittle	4. 4.5	In granitic rocks and pegmatites. With fergusonite, orthite, fluorite, molybdenite.
Pale yellowish brown Gray	C—Prismatic, pyramidal, not conspicuous F—Uneven Brittle	4.2 4.3	Not as heavy as cassiterite. Often in fine, hair-like inclusions. Widely distributed. With quartz, feldspar, ilmenite, chlorite, brookite, apatite.
Pale yellow Pale brown White	C—Indistinct F—Uneven Brittle	6.8 7.	Distinguished by high specific gravity. In veins cutting granite, gneiss; in alluvial deposits, as *stream tin*. With quartz, mica, wolframite, scheelite, arsenopyrite, molybdenite, tourmaline, fluorite, apatite, chlorite.

Streak—Black

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
WAD MnO_2 H_2O, etc.	Amorphous ? **M**—Earthy, sometimes with globular structure	Dull Submetallic Opaque	Brown Blackish brown
Covellite CuS	Hexagonal **C**—Tabular, rare **M**—Compact, granular, crusts	Submetallic Resinous Opaque	Indigo blu Blackish
BORNITE (Purple copper ore) Cu_5FeS_4	Cubic **C**—Rare **M**—Compact granular	Metallic Opaque	Bronze br Copper tarnishe readily
Uraninite (Pitchblende) UO_3, UO_2, PbO, etc.	Cubic **C**—Octahedral, rare **M**—Botryoidal, columnar, curved lamellar, granular compact, apparently amorphous	Submetallic Dull Opaque	Brown Blackish brown
PYRRHOTITE FeS	Hexagonal **C**—Tabular, rare **M**—Compact, granular	Metallic Opaque	Bronze b Bronze y
WOLFRAMITE $(Fe,Mn)WO_4$	Monoclinic **C**—Thick tabular, short columnar, often large **M**—Bladed, curved lamellar, granular	Submetallic Opaque	Grayish b Dark bro
Niccolite NiAs	Hexagonal **C**—Rare **M**—Compact, disseminated	Metallic Opaque	Light c red

Hardness 1 to 6

d- s	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
	Black Brownish black	F—Earthy Brittle	3. 4.3	Very soft varieties soil fingers. Apparently very light and floats on water, due to porosity. Usually adheres to tongue. With psilomelane, siderite, pyrolusite, limonite.
5	Dark gray Black	C—Basal, perfect F—Uneven Flexible in thin plates	4.6	Color very characteristic; bornite, blue only on surface. With chalcopyrite, bornite, chalcocite.
	Grayish black	C—Indistinct F—Uneven Brittle	4.9 5.2	Usually with peacock tarnish colors—purple copper ore. With chalcopyrite, chalcocite, malachite, cassiterite, siderite.
5	Brownish black Grayish black	F—Conchoidal, uneven Brittle	4.8 9.7	Structure and fracture important. Fresh material is hard and heavy. With ores of lead, silver, bismuth; also pyrite, thorite, orthite, fergusonite.
5 5	Dark grayish black	C—Basal, not conspicuous F—Uneven Brittle	4.5 4.6	Powder frequently attracted by magnet. Subject to dark brown tarnish. In basic igneous rocks. With chalcopyrite, pyrite, pentlandite, galena.
5	Black Brownish black	C—Clinopinacoidal, perfect, conspicuous F—Uneven Brittle	7.1 7.5	Structure, cleavage, specific gravity important. Powder may be slightly magnetic. With cassiterite, quartz, mica, fluorite, apatite, scheelite, molybdenite, huebnerite.
5	Dark brownish black	C—Indistinct F—Uneven Brittle	7.3 7.7	Often with green crust of annabergite (nickel bloom). With cobalt, nickel, silver minerals—smaltite, proustite, pyrargyrite, chloanthite; native bismuth and arsenic, calcite.

Streak—Green, red, brown, yellow, or black

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Ozocerite (Mineral wax, native paraffin) C_nH_{2n+2}	Never in crystals **M**—Compact, fibrous, lamellar	Waxy Submetallic Translucent	Black Brownish black
GRAPHITE (Plumbago, black lead) C	Hexagonal **C**—Tabular, rare **M**—Scaly, foliated, granular, earthy, sooty	Dull Opaque	Dark gray Iron black
CHLORITE (Pyrochlorite, clinochlorite) $H_8Mg_5Al_2Si_3O_{18}$?	Monoclinic **C**—Tabular, six-sided, often bent, twisted **M**—Foliated, scaly, granular, earthy	Dull Submetallic Translucent to opaque	Black Greenish black
MELACONITE CuO	Monoclinic **M**—Earthy, sooty	Dull Opaque	Iron black Dark gray
Asphalt (Mineral pitch) C, H, O, etc.	Amorphous Solid, or thick liquid	Pitchy Resinous Dull Opaque	Black Brownish black
WAD MnO_2, H_2O, etc.	Amorphous? **M**—Earthy, sometimes with globular structure	Dull Submetallic Opaque	Brownish black Black
Lignite (Brown coal) C, H, O, etc.	Amorphous **M**—Compact, fibrous, commonly with woody structure	Dull Opaque	Black Brownish black
Bituminous Coal (Soft Coal) C, H, O, etc.	Amorphous **M**—Compact, may show stratification; lamellar, fibrous	Pitchy Vitreous Dull Opaque	Black Brownish black
Anthracite Coal (Hard coal) C, principally	Amorphous **M**—Compact	Vitreous Submetallic Opaque	Iron black Black

Hardness 1 to 3

Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
Yellowish	C—None, apparently amorphous Plastic; may be sticky	0.9 1.	Easily indented by finger nail. Resembles impure wax. Greasy feel. In sandstones and shales; with petroleum and coal.
Dark gray Iron black	C—Basal, perfect (scales) Scales flexible	1.9 2.3	Greasy feel. Marks paper. Often impure. In marble with garnet, spinel, pyroxenes, amphiboles; also in shale, gneiss, mica schist.
Pale green	C—Basal, conspicuous, when foliated F—Scaly, earthy Touch to brittle	2.66 3.	Laminæ flexible but inelastic, with soapy feel. In schists and serpentine. With magnetite, magnesite, garnet, diopside. Pseudomorphous after garnet.
Black	F—Earthy	6.2	Coating on copper minerals, native copper, chalcopyrite, bornite, chrysocolla. Soils fingers.
Brownish black	C—None F—Conchoidal, conspicuous Brittle to flexible	1. 1.8	Bituminous odor when plastic. May be sticky. Independent deposits and impregnations in sand, shale, sandstone, limestone.
Dark brown Brownish black Black	F—Earthy Brittle	3. 4.3	May soil fingers. Apparently very light and floats on water, due to porosity. Usually adheres to tongue. With psilomelane, siderite, pyrolusite, limonite.
Brown Blackish brown	F—Conchoidal Brittle to tough	1.1 1.4	More or less carbonized plant remains. May disintegrate on exposure. *Jet*, compact, coal black variety with resinous luster.
Black Brownish black	F—Cubical, conchoidal Brittle	1.1 1.5	Distinguished from other coals by conspicuous cubical fracture. Sometimes shows iridescence, or distinct plant remains. With slate, pyrite, marcasite.
Black	F—Conchoidal, conspicuous Very brittle	1.3 1.7	Conchoidal fracture, luster, and absence of plant structure important. Often iridescent. With slate, pyrite, marcasite.

Streak—Green, red, brown, yellow, or black

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
*Atacamite $Cu(OH)Cl.Cu(OH)_2$	Orthorhombic **C**—Slender prismatic, usually in confused aggregates **M**—Fibrous, granular, compact, crusts, sand	Vitreous Adamantine Transparent to nearly opaque	Greenish b
Uraninite (Pitchblende) UO_3, UO_2, PbO, etc.	Cubic **C**—Octahedral, rare **M**—Botryoidal, columnar, curved lamellar, granular, compact, apparently amorphous	Pitch-like Submetallic Dull Opaque	Pitch black Brownish black Greenish black
SIDERITE $FeCO_3$	Hexagonal **C**—Rhombohedral, curved or saddle-shaped, common **M**—Cleavable, granular, compact, botryoidal	Vitreous Dull Translucent to opaque	Brownish black Black
SPHALERITE (Black Jack) ZnS	Cubic **C**—Tetrahedral, common **M**—Cleavable, fine and coarse grained, compact	Submetallic Resinous Opaque to translucent	Black Yellowish black Brownish black
***CUPRITE** Cu_2O	Cubic **C**—Octahedrons, dodecahedrons, alone or in combination, common **M**—Granular, compact, earthy	Adamantine Dull Translucent to opaque	Reddish bl
THORITE (Orangite) $ThSiO_4$	Tetragonal **C**—Square prisms with bipyramids **M**—Compact, disseminated	Vitreous Translucent to opaque	Black Brownish black

* Uncommon color.

Hardness 3 to 6

Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
Apple green	C—Brachypinacoidal F—Conchoidal Brittle	3.7 3.8	With other copper minerals; also limonite, hematite.
Olive green Dark brown Brownish black Grayish black	F—Conchoidal, uneven Brittle	4.8 9.7	Pitch-like appearance and fracture characteristic. Fresh material is hard and heavy. With lead, silver, bismuth minerals; also pyrite, thorite, orthite, fergusonite.
Yellowish brown	C—Rhombohedral, perfect, conspicuous F—Conchoidal Brittle	3.7 3.9	Curved crystals, cleavage, and rather high specific gravity characteristic. In ore deposits; beds and concretions in limestone and shale. With pyrite, chalcopyrite, galena, tetrahedrite, cryolite.
Dark brown Yellowish brown Gray	C—Dodecahedral perfect, usually conspicuous F—Conchoidal Brittle	3.9 4.2	Color and streak vary with impurities. When massive distinguished from siderite by cleavage. Extensively in limestone. With galena, chalcopyrite, pyrite, barite, fluorite, siderite, rhodochrosite, smithsonite.
Brownish red Dirty brown	C—Indistinct F—Uneven Brittle	5.7 6.1	Characterized by associates. With other copper minerals—malachite (green), azurite (blue), chalcocite and melaconite (black), chalcopyrite (yellow), native copper.
Light orange Dark brown	C—Prismatic, not conspicuous F—Conchoidal Brittle	4.4 5.4	Dark brown to black thorite sometimes contains a nucleus of yellow orangite; thorite believed to be decomposed orangite.

Streak—Green, red, brown, yellow, or black

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Goethite FeO.OH	Orthorhombic **C**—Small, thin tabular, needle-like; parallelly grouped **M**—Reniform, stalactitic	Adamantine Dull Translucent to opaque	Brownish black Black
Huebnerite $MnWO_4$	Monoclinic **C**—Long fibrous, bladed, stalky; often divergent **M**—Compact, lamellar, granular	Resinous Submetallic Translucent to opaque	Brownish black Black
WOLFRAMITE $(Fe,Mn)WO_4$	Monoclinic **C**—Thick tabular, short columnar, often large **M**—Bladed, curved lamellar, granular	Submetallic Opaque	Dark gray Brownish black Iron black
Ferberite $FeWO_4$	Monoclinic **C**—Wedge shaped, short prismatic, tabular **M**—Bladed, fan shaped; granular, compact	Submetallic Splendent Opaque	Iron black Brownish black
HORNBLENDE (Amphibole) Silicate of Ca, Mg, Fe, Al, etc.	Monoclinic **C**—Long prismatic, prism angle 124°; with rhombohedral-like terminations **M**—Bladed, fibrous, granular, compact	Vitreous Silky Translucent to opaque	Pitch black Greenish black Brownish black
AUGITE (Pyroxene) Silicate of Ca, Mg, Fe, Al, etc.	Monoclinic **C**—Short prismatic; thick columnar, prism angle 87° **M**—Compact, granular, disseminated	Vitreous Submetallic Translucent to opaque	Pitch blac Greenish b Brownish black
Psilomelane MnO_2, BaO, H_2O, etc.	Amorphous? **M**—Botryoidal, reniform, stalactitic; smooth surface	Submetallic Dull Opaque	Iron black Bluish bla Dark gray

Hardness 3 to 6

Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
Yellow Yellowish brown	C—Brachypinacoidal F—Uneven, splintery Brittle	4. 4.4	Usually with other iron minerals; in cavities in hematite or limonite. Often as scaly, fibrous, velvety crusts.
Yellowish brown	C—Clinopinacoidal, perfect, conspicuous Brittle	6.7 7.3	Structure, cleavage, and high specific gravity characteristic. In quartz veins. With wolframite, fluorite, pyrite, scheelite, galena, tetranedrite.
Dark reddish brown Black	C—Clinopinacoidal, perfect, conspicuous F—Uneven Brittle	7.1 7.5	Distinguished from huebnerite by streak. Powder may be slightly magnetic. With cassiterite, quartz, mica, fluorite, apatite, scheelite, molybdenite, huebnerite.
Brownish black	C—Clinopinacoidal, perfect F—Uneven Brittle	7.1 7.5	In granites and pegmatites. With quartz, chalcopyrite, galena, scheelite.
Grayish green Grayish brown Yellow	C—Prismatic, perfect, often conspicuous —124° Brittle	2.9 3.3	Simple, pseudohexagonal crystals, and cleavage at 124° important. Very common; in nearly all types of rocks. With calcite, quartz, feldspar, pyroxene, chlorite.
Pale green Grayish green	C—Prismatic, perfect, conspicuous—87° Brittle	3.2 3.6	Crystals eight-, more rarely four-sided; pseudotetragonal with prism angles of 87° and 93°. Cleavage less distinct than on hornblende. Common in basic eruptive rocks and crystalline limestones.
Black Brownish black	F—Conchoidal, uneven Brittle	3.7 4.7	Often with fine sooty coating of pyrolusite. With other manganese minerals; also limonite, barite.

Streak—Green, red, brown, yellow, or black

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
LIMONITE $Fe_2O_3.nH_2O$	C—Pseudomorphs, after pyrite, marcasite, siderite M—Compact, stalactitic, botryoidal, reniform; fibrous structure	Metallic Dull Opaque	Black Brownish black
CHROMITE $(Fe,Cr)[(Cr,Fe)O_2]_2$	Cubic C—Octahedral, rare M—Compact, granular, disseminated grains	Submetallic Pitchy Opaque	Iron black Brownish black
Orthite (Allanite) $Ca_2(Al,Ce,Fe)_2(Al.OH)(SiO_4)_3$	Monoclinic C—Tabular, rare M—Compact, granular, bladed, disseminated grains	Submetallic Greasy Translucent to opaque	Black Pitch black Brownish black
Brookite TiO_2	Orthorhombic Only in crystals,—pyramidal (often with hexagonal habit), prismatic, tabular	Adamantine Metallic Opaque	Iron black Reddish bla Brownish black
Ilvaite $CaFe_2(Fe.OH)(SiO_4)_2$	Orthorhombic C—Columnar, acicular, vertically striated M—Compact, radial fibrous granular	Vitreous Submetallic Opaque	Black Greenish b Brownish black

Streak—Green, red, brown, yellow, or black

Chloritoid $H_2FeAl_2SiO_7$	Monoclinic C—Tabular, six-sided M—Foliated, scaly, platy; fan- and sheaf-like aggregates	Vitreous Pearly Translucent to opaque	Dark gray Greenish gr Greenish b
RUTILE TiO_2 or $TiTiO_4$	Tetragonal C—Prismatic, vertically striated; knee-shaped or rosette twins M—Compact, disseminated	Adamantine Metallic Opaque to transparent	Iron black Brownish black Reddish bla

Hardness 3 to 6

Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
Yellowish brown	**F**—Conchoidal, splintery Brittle	3.6 4.	Often with black varnish-like surface, passing into the soft, yellow earthy or ocherous variety. With pyrite, hematite, magnetite, siderite.
Dark brown Grayish brown	**C**—Indistinct **F**—Uneven, conchoidal Brittle	4.3 4.6	May be slightly magnetic. Pitch-like appearance. With serpentine, talc; garnet, zaratite; in black sands, platinum placers.
Pale brown Grayish brown	**C**—Pinacoidal, indistinct **F**—Uneven, conchoidal Brittle	3. 4.	Often covered with yellowish or brownish alteration product. Disseminated in acid igneous rocks; in limestones. With magnetite, epidote, quartz, feldspar.
Yellowish Brownish	**C**—Indistinct **F**—Uneven Brittle	3.8 4.1	Crystals may be deeply striated; not twinned like rutile. With rutile, anatase, titanite, adularia, nephelite.
Blackish	**C**—Pinacoidal **F**—Uneven Brittle	3.9 4.1	Often covered with yellowish alteration product and, hence, softer. With dolomite, pyroxene, iron minerals.

Hardness over 6

Pale green	**C**—Basal, perfect, conspicuous **F**—Scaly Brittle	3.4 3.6	Softer when altered. Easily recognized by micaceous structure and perfect cleavage. In clay slates, mica schists. With corundum, garnet, chlorite, hornblende.
Pale yellow Pale brown	**C**—Prismatic, pyramidal, not conspicuous **F**—Uneven Brittle	4.2 4.3	Not as heavy as cassiterite. Often in fine hair-like inclusions. Widely distributed. With quartz, feldspar, hematite, ilmenite, chlorite, brookite.

Streak—Green, red, brown, yellow, or black

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
CASSITERITE SnO_2 or $SnSnO_4$	Tetragonal **C**—Thick prismatic; knee-shaped twins quite common **M**—Compact, reniform, botryoidal, pebbles, with radial fibrous structure	Submetallic Dull Translucent to opaque	Black Brownish black
Piedmontite $Ca_2(Mn,Al)_2(Al.OH)(SiO_4)_3$	Monoclinic **C**—Prismatic, similar to epidote **M**—Columnar, radial aggregates	Vitreous to submetallic Translucent to opaque	Reddish br Reddish bl
CORUNDUM, variety *Emery* Al_2O_3, with Fe_3O_4,Fe_2O_3, SiO_2	Hexagonal **M**—Fine to coarse granular	Dull Submetallic Opaque	Dark gray Black
SPINEL, varieties *Hercynite* $M''(M'''O_2)_2$ *Picotite* $M'' = Mg$, Fe, Zn, Mn $M''' = Al$, Fe	Cubic **C**—Octahedral, small **M**—Compact, granular, disseminated grains	Vitreous Dull Nearly opaque	Black Brownish black

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
*__GYPSUM__, varieties *Selenite* $CaSO_4.2H_2O$ *Satin spar*	Monoclinic **C**—Tabular, prismatic; swallow-tail twins **M**—Cleavable, coarse and fine granular, fibrous, foliated, earthy, sand	Pearly Vitreous Silky Dull Transparent to opaque	Dark gray Black
*__HALITE__ (Rock salt) NaCl	Cubic **C**—Cubes, often skeletal or hopper-shaped **M**—Compact, granular, cleavable, fibrous crusts	Vitreous Translucent to nearly opaque	Dark gray Black

* Uncommon color.

Hardness over 6

Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
Pale brown Pale yellow	C—Indistinct F—Uneven Brittle	6.8 7.	Distinguished by high specific gravity. In veins cutting granite, gneiss; in alluvial deposits as *stream tin*. With quartz, mica, wolframite, scheelite, arsenopyrite, molybdenite, tourmaline, fluorite, apatite, chlorite.
Cherry red Red brown	C—Basal F—Uneven Brittle	3.3	In gneiss and schists with quartz, chlorite, braunite, tremolite, glaucophane.
Yellowish brown Black	C—Indistinct F—Uneven Brittle to tough	3.7 4.3	Corundum mixed with magnetite, hematite, quartz. Resembles iron ore. Powder may be magnetic. Properties vary. With mica, amphibole, chlorite, spinel; in crystalline limestones, schists, peridotites.
Grayish green Pale brown	C—Octahedral, indistinct F—Conchoidal Brittle	3.9 4.1	Commonly in basic igneous rocks, especially the olivine-bearing types. With olivine, serpentine, corundum, magnetite, hornblende, garnet.

Hardness 1 to 3

White	C—Clinopinacoidal, perfect, conspicuous; pyramidal, orthopinacoidal F—Conchoidal Brittle, lamellæ flexible	2.2 2.4	Color due to organic material. *Selenite*, crystals and cleavage plates; *satin spar*, fibrous, with silky luster. In limestones, shales. With halite, celestite, sulphur, aragonite, anhydrite, ore deposits.
White	C—Cubic, perfect, conspicuous F—Conchoidal Brittle	2.1 2.3	Color due to organic matter. Characteristic cubical cleavage and saline taste. May absorb moisture and become damp. With shale, gypsum, anhydrite, polyhalite.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
APATITE, variety *Phosphate rock* Mainly calcium carbonate—phosphate (collophane)	Amorphous **M**—Compact, nodular, reniform, earthy	Dull Opaque	Black
***CRYOLITE** Na_3AlF_6	Monoclinic **C**—Small, pseudocubical, rare **M**—Cleavable, granular	Vitreous Greasy Translucent to nearly opaque	Brownish black Blackish
BIOTITE (Black mica) $(K,H)_2(Mg,Fe)_2(Al,Fe)_2(SiO_4)_3$	Monoclinic **C**—Tabular, with hexagonal or rhombohedral habit **M**—Plates, disseminated scales	Pearly Submetallic Transparent to opaque	Black Brownish black Greenish b
CALCITE, varieties $CaCO_3$ *Anthraconite* *Limestone* *Marble* *Stagmites* *Calcareous tufa* *Travertine*	Hexagonal **M**—Cleavable, granular, fibrous, banded, stalactitic, oolitic, porous, compact, crusts, shells	Vitreous Dull Translucent to opaque	Dark gray Brownish black Black

Streak—Uncolored, white, or light gray

ANHYDRITE $CaSO_4$	Orthorhombic **C**—Thick tabular, prismatic, rare **M**—Granular, compact, fibrous, lamellar, cleavable	Vitreous Pearly Translucent to opaque	Dark gray Blackish

* Uncommon color.

Hardness 1 to 3

Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
White	**F**—Conchoidal, uneven Brittle	3.1 3.2	More or less impure masses, frequently resembling compact bituminous limestone. Independent beds, nodules, or concretions.
White	**C**—Basal, prismatic, perfect, nearly 90°; sometimes conspicuous **F**—Uneven Brittle	2.9 3.	Often contains disseminated siderite, chalcopyrite, galena, pyrite, sphalerite, fluorite, columbite.
White Grayish	**C**—Basal, perfect, conspicuous Tough, lamellæ of fresh biotite very elastic	2.7 3.2	Easily recognized by structure, highly perfect cleavage, and elasticity. Important constituent of many igneous and metamorphic rocks—granite, syenite, gneiss.
White Gray	**C**—Rhombohedral, perfect **F**—Conchoidal Brittle	2.7	Rhombohedral cleavage generally observed. Cleavages often striated. Yields bituminous odor when struck with hammer. To distinguish varieties, see references.

Hardness 3 to 6

White	**C**—Pinacoidal, perfect, 3 directions at 90° **F**—Conchoidal Brittle	2.8 3.	Color due to organic matter. Pseudocubical cleavage sometimes noted. Granular varieties resemble marble. In limestones, shales. With halite, gypsum.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
*CERUSSITE $PbCO_3$	Orthorhombic C—Tabular, prismatic, pyramidal; pseudo-hexagonal, clusters or star-shaped group M—Interlaced bundles, granular, stalactitic, compact, earthy	Adamantine Greasy Silky Translucent to opaque	Grayish black Black
SERPENTINE $H_4Mg_3Si_2O_9$	Monoclinic C—Unknown M—Compact, columnar, fibrous, lamellar, granular	Greasy Waxy Translucent to opaque	Greenish black Brownish black
*APATITE, variety *Phosphate rock* Mainly calcium carbonate—phosphate (collophane)	Amorphous M—Compact, nodular, reniform, earthy	Dull Opaque	Black
*Wavellite $(Al.OH)_3(PO_4)_2.5H_2O$	Orthorhombic C—Capillary, small M—Crusts, globular or hemispherical with radial fibrous structure	Vitreous Translucent	Black Dark gray
*DOLOMITE $CaMg(CO_3)_2$	Hexagonal M—Coarsely crystalline, compact, granular, friable	Vitreous Translucent to opaque	Grayish black Brownish black
SPHALERITE (Black Jack) ZnS	Cubic C—Tetrahedral, common M—Cleavable, fine or coarse grained, compact	Submetallic Opaque to translucent	Black Brownish black Yellowish black
*MAGNESITE $MgCO_3$	Hexagonal C—Rhombohedral, rare M—Granular, compact, earthy	Vitreous Dull Translucent to opaque	Grayish black Brownish black

* Uncommon color.

Hardness 3 to 6

rd-ss	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
5	White Gray	C—Indistinct F—Conchoidal Very brittle	6.5 6.6	Color due to admixture of fine particles of galena. Twinning, structure, luster, and high specific gravity characteristic. With lead minerals—galena, pyromorphite, anglesite; also malachite, limonite.
	White	F—Conchoidal, splintery Brittle	2.5 2.8	Smooth and greasy feel. Often spotted, clouded, multi-colored. Sometimes crossed by seams of asbestos (chrysotile). With magnesite, calcite, chromite, garnierite, pyrope, platinum.
	White	F—Conchoidal, uneven Brittle	3.1 3.2	More or less impure masses frequently resembling compact, bituminous limestone. Independent beds, nodules, or concretions.
5	White	C—Pinacoidal, domatic F—Uneven, fibrous Brittle	2.3 2.4	Secondary mineral, occurring on surfaces of rocks or minerals as crystalline crusts with pronounced radial fibrous structure.
5	White Gray	C—Rhombohedral F—Conchoidal Brittle	2.9	Color largely due to organic matter; yields bituminous odor when struck with hammer; may be banded. In independent beds, fissures, and cavities; ore deposits.
5	Grayish	C—Dodecahedral, perfect, usually conspicuous F—Conchoidal Brittle	3.9 4.2	Color and streak vary with impurities. Extensively in limestones with galena, chalcopyrite, pyrite, barite, fluorite, siderite, rhodochrosite, smithsonite.
5	White	C—Rhombohedral, perfect (crystals) F—Conchoidal, conspicuous Tough to brittle	2.9 3.1	Conchoidal fracture generally prominent. Compact varieties apparently very hard. Disseminated in talcose and chloritic schists, serpentine, gypsum; independent deposits.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
*FLUORITE (Fluor spar) CaF_2	Cubic C—Cubes, alone or modified, well developed, common; penetration twins M—Cleavable, granular, fibrous	Vitreous Transparent to nearly opaque	Purplish black Brownish black Black
Huebnerite $MnWO_4$	Monoclinic C—Long fibrous, bladed, stalky, often divergent, without good terminations M—Compact, lamellar, granular	Resinous Submetallic Translucent to opaque	Brownish black Black
* TITANITE (Sphene) $CaTiSiO_5$	Monoclinic C—Wedge- or envelope-shaped when disseminated; tabular or prismatic when attached M—Compact, lamellar	Vitreous Submetallic Translucent to opaque	Black Brownish black
HORNBLENDE (Amphibole) Silicate of Ca, Mg, Fe, Al, etc.	Monoclinic C—Long prismatic, prism angle 124°, often with rhombohedral-like terminations M—Bladed, fibrous, granular, compact	Vitreous Silky Translucent to opaque	Pitch black Greenish black Brownish black
PYROXENES AUGITE Silicate of Ca, Mg, Fe, Al, etc.	Monoclinic C—Short prismatic, thick columnar, prism angle 87° M—Compact, granular, disseminated	Vitreous Submetallic Translucent to opaque	Pitch black Greenish black Brownish black
PYROXENES Hypersthene $(Fe,Mg)_2(SiO_3)_2$	Orthorhombic C—Prismatic, tabular, rare M—Granular, foliated, cleavable aggregates	Pearly Metalloidal Translucent to opaque	Black Brownish black Greenish b

* Uncommon color.

Hardness 3 to 6

d-s	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
	White	C—Octahedral, perfect, conspicuous Brittle	3. 3.2	Easily recognized by crystal form and octahedral cleavage. Common gangue mineral of metallic ores, especially galena, sphalerite, cassiterite; also with calcite, quartz, barite.
5 5	Greenish gray	C—Clinopinacoidal, perfect, conspicuous Brittle	6.7 7.3	Structure, cleavage, and specific gravity characteristic. In quartz veins. With wolframite, fluorite, pyrite, scheelite, galena, tetrahedrite.
5	White Gray	C—Prismatic, conspicuous partings often noted F—Conchoidal Brittle	3.4 3.6	With feldspars, pyroxenes, amphiboles, chlorite, scapolite, zircon.
	Gray Greenish gray Browinsh gray	C—Prismatic, perfect, often conspicuous —124° Brittle	2.9 3.3	Simple, pseudohexagonal crystals, and cleavage (124°) important. Very common. In nearly all types of rocks. With feldspars, quartz, pyroxenes, chlorite, calcite.
	White Gray Greenish gray	C—Prismatic, perfect, conspicuous—87° Brittle	3.2 3.6	Crystals usually eight-sided, more rarely four-sided; pseudotetragonal with prism angles of 87° and 93°. Cleavage less distinct than on hornblende. Common in basic eruptive rocks and crystalline limestones.
	White Gray Brownish gray	C—Brachypinacoidal, perfect, conspicuous F—Uneven Brittle	3.3 3.5	Copper red iridescence often noted, due to small tabular inclusions. Commonly in the more basic igneous rocks. With feldspar (labradorite), olivine, hornblende, pyrrhotite, magnetite.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Orthite (Allanite) $Ca_2(Al,Ce,Fe)_2(Al.OH)(SiO_4)_3$	Monoclinic C—Tabular, rare M—Compact, granular, bladed, disseminated grains	Submetallic Greasy Translucent to opaque	Black Pitch black Brownish black
Anatase (Octahedrite) TiO_2	Tetragonal C—Pyramidal, tabular, rarely prismatic	Metallic Adamantine Opaque to translucent	Black Brownish black Reddish bla
Brookite TiO_2	Orthorhombic Only in crystals,—pyramidal (often hexagonal habit), prismatic, tabular	Adamantine Metallic Opaque to translucent	Iron black Reddish bla Brownish bl
Perovskite $CaTiO_3$	Pseudocubic C—Apparently cubes, highly modified, often striated M—Reniform aggregates, rounded grains	Submetallic Adamantine Opaque	Black Grayish black Brownish black

Streak—Uncolored, white, or light gray

Aegirite (Pyroxene) $NaFe(SiO_3)_2$	Monoclinic C—Prismatic M—Fibrous, acicular; often in tufts	Vitreous Submetallic Translucent to opaque	Greenish bl Brownish bl
LABRADORITE (Feldspar) Silicate of Na,Ca,Al	Triclinic C—Thin tabular; rhombic cross-section M—Compact, cleavable, granular	Vitreous Pearly Translucent to nearly opaque	Dark gray Greenish gray
EPIDOTE $Ca_2(Al.Fe)_2(Al.OH)(SiO_4)$	Monoclinic C—Prismatic, parallel to *b* axis; striated; faces on one end only. M—Columnar, fibrous, parallel and divergent, granular	Vitreous Translucent to opaque	Greenish black

Hardness 3 to 6

rd-ss	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
5	Gray Greenish gray Brownish gray	C—Pinacoidal, indistinct F—Uneven, conchoidal Brittle	3. 4.	Often covered with yellowish or brownish alteration product. Disseminated in acid igneous rocks; limestones. With magnetite, epidote, quartz, feldspars.
5	Gray White	C—Pyramidal, basal F—Subconchoidal Brittle	3.8 3.9	Crystals often resemble elongated octahedrons. With brookite, rutile, ilmenite, adularia, titanite, gold.
5	Gray Yellowish white Brownish white	C—Indistinct F—Uneven Brittle	3.8 4.1	Crystals may be deeply striated; not twinned like rutile. With rutile, anatase, titanite, adularia, nephelite.
5	White Grayish	C—Cubical, fairly distinct F—Uneven Brittle	4. 4.1	With chlorite, magnetite, limestone, serpentine.

Hardness over 6

5	Grayish	C—Prismatic, perfect	3.5	In pegmatites and igneous rocks. With leucite, nephelite, feldspars. With blunt end faces, *aegirite;* with acute, *acmite.*
5	White	C—Basal, brachypinacoidal, perfect, conspicuous—86° F—Uneven, conchoidal Brittle	2.7	Often with play of colors—yellow, green, blue, red. Inclined cleavages are striated. In basic igneous rocks. With pyroxenes, amphiboles.
	White Grayish	C—Basal, perfect F—Uneven Brittle	3.3 3.5	Crystals are often dark green or blackish green, massive aggregates lighter colored. Widely distributed. With quartz, feldspar, garnet, hornblende, pyroxene, prehnite, magnetite, native copper.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
CHLORITOID $H_2FeAl_2SiO_7$	Monoclinic **C**—Tabular, six-sided **M**—Foliated, scaly, platy, granular; fan- and sheaf-like aggregates	Vitreous Pearly Translucent to opaque	Dark gray Greenish gra Greenish bla
Gadolinite $Fe[Be(Y.O)SiO_4]_2$	Monoclinic **C**—Prismatic, rough, rare **M**—Compact, disseminated	Vitreous Greasy Translucent to opaque	Black Greenish black
RUTILE TiO_2 or $TiTiO_4$	Tetragonal **C**—Prismatic, vertically striated; twinned, yielding knee-shaped or rosette forms **M**—Compact, disseminated	Metallic Adamantine Opaque to translucent	Iron black Brownish black Reddish bla
CASSITERITE SnO_2 or $SnSnO_4$	Tetragonal **C**—Thick prismatic, knee-shaped twins, quite common **M**—Compact, reniform, botryoidal, rounded pebbles, often with internal, radial fibrous structure	Submetallic Dull Translucent to opaque	Black Brownish black
GARNET, varieties *Andradite, Almandite* $M_3''M_2'''(SiO_4)_3$ M'' = Ca, Fe, Mg M''' = Al, Fe	Cubic **C**—Dodecahedrons, tetragonal trisoctahedrons, alone or in combination **M**—Granular, compact, lamellar, disseminated, sand	Vitreous Translucent to opaque	Velvety bla Brownish black

Hardness over 6

d-s	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
	White Greenish white Grayish	C—Basal, perfect, conspicuous F—Scaly Brittle	3.4 3.6	Sometimes softer due to alteration. Easily recognized by micaceous structure and perfect cleavage. In clay slates, mica schists. With corundum, garnet, chlorite, hornblende.
	Greenish gray	C—None F—Conchoidal, splintery Brittle	4. 4.5	In granitic rocks and pegmatites. With fergusonite, orthite, fluorite, molybdenite.
	Gray Yellowish white Brownish white	C—Prismatic, pyramidal, not conspicuous F—Uneven Brittle	4.2 4.3	Not as heavy as cassiterite. Often in hair-like inclusions. Widely distributed. With quartz, feldspar, hematite, ilmenite, chlorite, brookite.
	White Yellowish white Brownish white	C—Indistinct F—Uneven Brittle	6.8 7.	Distinguished by high specific gravity. In veins cutting granite, gneiss; in alluvial deposits as *stream tin*. With quartz, mica, wolframite, scheelite, molybdenite, tourmaline, fluorite, chlorite.
5 5	White	C—Dodecahedral, usually indistinct F—Conchoidal, uneven Brittle	3.8 4.2	*Andradite*, commonly with magnetite, epidote, feldspars, nephelite, leucite; *almandite*, with mica, staurolite, andalusite, cyanite, tourmaline.

Streak—Uncolored, white, or light gray

Name Composition		Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
QUARTZ, SiO_2	Crystalline variety *Smoky quartz*	Hexagonal **C**—Prismatic, horizontally striated **M**—Compact, granular	Vitreous Transparent to translucent	Grayish bla Brownish black
	Cryptocrystalline varieties *Chalcedony* *Onyx* *Flint* *Basanite*	Hexagonal Fine crystalline masses, banded, nodular, botryoidal, stalactitic	Waxy Vitreous Translucent to opaque	Grayish bla Brownish black Velvet black
TOURMALINE, variety *Schorl* $M'_{20}B_2Si_4O_{21}$ M′ = Na, K, Li, Mg, Ca, (OH), Fe, Al		Hexagonal **C**—Prismatic, vertically striated; terminated with broken or rhombohedral-like surfaces; well developed crystals are hemimorphic **M**—Compact, divergent columnar	Pitchy Vitreous Translucent to opaque	Pitch black Brownish black Bluish black
STAUROLITE $Fe(AlO)_4(Al.OH)(SiO_4)_2$		Orthorhombic **C**—Prismatic; twins plus (+) or X-shaped, well developed, often large	Vitreous Dull Translucent to opaque	Brownish black Dark gray
SPINEL, varieties $M''(M'''O_2)_2$ M″ = Mg, Fe, Zn, Mn M‴ = Al, Fe	*Pleonaste* *Gahnite* *Dysluite*	Cubic **C**—Octahedral, well developed, common **M**—Compact, granular, disseminated grains	Vitreous Dull Nearly opaque	Brownish black Grayish bla Greenish bl

Hardness over 6

Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
White	C—Indistinct F—Conchoidal, conspicuous, Brittle	2.6	Characteristic conchoidal fracture and glassy luster. Common in granitic rocks.
White	C—Indistinct F—Conchoidal, conspicuous Brittle to tough	2.6	Conchoidal fracture characteristic. *Chalcedony*, waxy luster; *onyx*, banded; *flint*, generally with white coating; *basanite*, velvet black.
White Gray	C—None F—Conchoidal, uneven Brittle	2.9 3.2	Spherical triangular cross-section, coal black color, and lack of cleavage important. In pegmatites; metamorphic rocks; alluvial deposits. With quartz, feldspar, cassiterite, beryl, topaz, fluorite.
White Gray	C—Brachypinacoidal F—Conchoidal, uneven Brittle	3.4 3.8	Fresh crystals usually possess bright and smooth faces, when altered dull, rough, softer, and with colored streak. In metamorphic rocks—gneiss, mica schist, slate. With cyanite, garnet, tourmaline, sillimanite.
White Grayish	C—Octahedral, indistinct F—Conchoidal	3.6 4.4	Commonly as contact mineral in granular limestones; in more basic igneous rocks; rounded grains in placers. With calcite, chondrodite, serpentine, brucite, corundum, graphite, pyroxene, phlogopite.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
CORUNDUM, variety *common* Al_2O_3	Hexagonal **C**—Prismatic, tabular, pyramidal, rhombohedral; rounded barrel-shaped **M**—Compact, lamellar	Vitreous Translucent to transparent	Yellow Brown
DIAMOND, varieties *Diamond proper* *Bort* *Carbonado* C	Cubic **C**—Octahedrons, hexoctahedrons, usually with curved surfaces **M**—Rounded or irregular grains or pebbles, often with radial structure	Adamantine Vitreous Translucent to opaque	Black Dark gray

Hardness over 6

d- s	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
	White	**C**—None, nearly rectangular basal and rhombohedral partings, conspicuous; striated **F**—Conchoidal Brittle to tough	3.9 4.1	In limestone, granite, syenite, alluvial deposits. With magnetite, nephelite, mica, spinel, chlorite.
	Ash gray	**C**—Octahedral, perfect (diamond proper) **F**—Conchoidal Brittle	3.1 3.5	*Diamond proper*, crystals and cleavage fragments; *bort*, translucent with radial structure, also crystal fragments; *carbonado*, granular to compact, opaque. In serpentine rocks—kimberlite, peridotite—called *blue ground*, or in placers. With pyrope, magnetite, chromite, cassiterite, zircon, gold.

Streak—Pink, red, brown, or yellow

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
BAUXITE $Al_2O(OH)_4$	Never in crystals **M**—Pisolitic, oolitic, rounded disseminated grains, clay-like, earthy	Dull Earthy Opaque	Red Reddish brown
HEMATITE, varieties *Red ocher* *Oolitic* *Fossiliferous* Fe_2O_3	Hexagonal **M**—Fine granular, earthy, oolitic, replacement of shells	Dull Opaque	Brownish red Cherry red
REALGAR AsS	Monoclinic **C**—Short prismatic, rare **M**—Granular, compact, incrustations	Resinous Transparent to translucent	Aurora red Orange yellow
Erythrite (Cobalt bloom) $Co_3(AsO_4)_2.8H_2O$	Monoclinic **C**—Acicular, vertically striated, small, rare **M**—Globular, reniform, earthy, crusts, stains	Adamantine Dull Transparent to opaque	Crimson Peach red Pink
CINNABAR HgS	Hexagonal **C**—Rhombohedral, thick tabular, small **M**—Fine granular, fibrous, earthy coatings	Adamantine Dull Transparent to opaque	Scarlet red Brownish
Proustite Ag_3AsS_3	Hexagonal **C**—Small, complex, rare **M**—Compact, disseminated, crusts, bands	Adamantine Dull Translucent to transparent	Scarlet Vermilion
Crocoite $PbCrO_4$	Monoclinic **C**—Prismatic, acicular **M**—Columnar, granular, crusts	Adamantine Greasy Translucent	Hyacinth Aurora red

Hardness 1 to 3

Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
Reddish Yellowish	F—Earthy Brittle	2.5 2.6	Color and streak variable, due to pigments. Clay odor when breathed upon. Distinguished from clay by pisolitic or oolitic structure. With clay or kaolinite in nodules, grains, or irregular deposits in limestone or dolomite.
Cherry red Reddish brown	C—None F—Earthy Brittle	4.9 5.3	*Red ocher*, red earthy variety; *oolitic hematite*, fish-egg structure; *fossiliferous hematite*, replacement of shells.
Orange yellow	C—Clinopinacoidal, basal F—Conchoidal Slightly sectile	3.4 3.6	Frequently disseminated in clay or dolomite. With orpiment, stibnite, native arsenic, pyrite, barite, calcite.
Pink Pale red	C—Clinopinacoidal, F—Fibrous, earthy Sectile, thin laminæ flexible	3.	Crystals frequently in spherical or stellate groups with velvety surface. Usually earthy. Color fades on exposure. Common alteration product of cobalt-arsenic minerals—cobaltite, smaltite, chloanthite.
Scarlet Red brown	C—Prismatic, not conspicuous F—Uneven Brittle to sectile	8. 8.2	Characterized by color, streak, and high specific gravity (often lowered by gangue). Disseminated through silicious rocks. With native mercury, pyrite, marcasite, realgar, stibnite.
Scarlet Aurora red	C—Imperfect F—Conchoidal Brittle	5.5 5.6	*Light ruby silver ore.* Distinguished from cinnabar by associates. With pyrargyrite, in veins with other silver minerals and galena. Compare pyrargyrite
Orange yellow	C—Basal, prismatic F—Conchoidal, uneven Sectile	5.9 6.1	Resembles potassium bichromate in color. Alteration product of galena. With galena, quartz, pyrite, vanadinite, wulfenite.

Streak—Pink, red, brown, or yellow

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Pyrargyrite Ag_3SbS_3	Hexagonal **C**—Small, complex, rare **M**—Compact, disseminated, crusts, bands	Adamantine Metallic Transparent to opaque	Dark red
Wulfenite $PbMoO_4$	Tetragonal **C**—Square, thin tabular, more rarely pyramidal **M**—Coarse, fine granular	Resinous Adamantine Transparent to translucent	Orange red Bright red
Vanadinite $Pb_5Cl(VO_4)_3$	Hexagonal **C**—Prismatic, small, at times skeletal **M**—Compact, globular, fibrous, crusts	Resinous Translucent to opaque	Ruby red Brownish r Orange red

Streak—Pink, red, brown, or yellow

HEMATITE, varieties *Argillaceous* *Compact* Fe_2O_3	Hexagonal **M**—Compact, granular, columnar, splintery, radiated reniform or botryoidal	Submetallic Dull Opaque	Brownish Dark red
SPHALERITE ZnS	Cubic **C**—Tetrahedral, common **M**—Cleavable, fine to coarse granular, compact	Resinous Submetallic Translucent to opaque	Brownish red Yellowish
CUPRITE Cu_2O	Cubic **C**—Octahedrons, dodecahedrons, alone or in combination **M**—Granular, earthy; slender crystal aggregates (*chalcotrichite*)	Adamantine Dull Translucent to opaque	Cochineal Brick red Dark red

Hardness 1 to 3

Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
Cherry red Purplish red	C—Indistinct F—Conchoidal Brittle	5.8	Frequently as gray or dark red bands. Darker than proustite—*dark ruby silver ore.* With proustite, in veins with other silver minerals and galena.
Lemon yellow Pale yellow	C—Pyramidal, indistinct F—Conchoidal, uneven Brittle	6.3 7.	Square plates, sometimes with forms of the third order. With lead minerals—galena, pyromorphite, vanadinite.
Pale yellow Yellow	C—None F—Conchoidal, uneven Brittle	6.7 7.2	Crystal faces smooth with sharp edges. With lead minerals but never in large quantities.

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Hardness over 3

Cherry red Reddish brown	C—None F—Uneven, splintery Brittle	4.9 5.3	*Argillaceous hematite,* impure from clay, sand, jasper; *compact hematite,* usually quite pure.
Pale yellow Brownish yellow	C—Dodecahedral, perfect, usually conspicuous F—Conchoidal Brittle	3.9 4.2	Color and streak vary with impurities. Extensively in limestone. With galena, chalcopyrite, pyrite, barite, fluorite, siderite, rhodochrosite, smithsonite.
Brownish red Dirty brown	C—Indistinct F—Uneven Brittle	5.7 6.1	Characterized by associates, copper minerals—malachite (green) azurite (blue), chalcocite and melaconite (black), chalcopyrite (yellow), native copper.

Streak—Pink, red, brown, or yellow

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Zincite ZnO	Hexagonal **C**—Hemimorphic, rare **M**—Compact, granular, foliated	Adamantine Vitreous Translucent to opaque	Dark red Blood red
***Xenotime** YPO_4	Tetragonal **C**—Pyramidal, prismatic **M**—Compact, disseminated, rounded grains	Greasy Vitreous Translucent to opaque	Flesh red Brownish Yellowish
Goethite FeO.OH	Orthorhombic **C**—Small, thin tabular, needle-like; parallelly grouped or scaly, fibrous, velvety crusts **M**—Reniform, stalactitic	Adamantine Dull Translucent to opaque	Reddish Brownish
Huebnerite $MnWO_4$	Monoclinic **C**—Long, fibrous, bladed, stalky; often divergent, without good terminations **M**—Compact, lamellar, granular	Greasy Submetallic Translucent to opaque	Brownish
WOLFRAMITE $(Fe,Mn)WO_4$	Monoclinic **C**—Thick tabular, short columnar, often large **M**—Bladed, curved lamellar, granular, compact	Submetallic Opaque	Brownish
RUTILE TiO_2 or $TiTiO_4$	Tetragonal **C**—Prismatic, vertically striated; twinned, yielding knee-shaped or rosette forms **M**—Compact, disseminated	Adamantine Submetallic Translucent to opaque	Dark red Brownish

* Uncommon color.

Hardness over 3

Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
Orange yellow Reddish yellow	C—Basal, sometimes conspicuous F—Uneven Brittle	5.4	Associates important—calcite, franklinite (black), willemite (yellow to green), rhodonite (flesh red). On exposure becomes coated with the white carbonate.
Pale brown Yellowish Reddish	C—Prismatic F—Uneven, splintery Brittle	4.4 4.6	Commonly as loose, disseminated, or attached crystals resembling zircon, but softer. In granite and gneiss with zircon; alluvial deposits.
Yellowish Yellowish brown	C—Brachypinacoidal F—Uneven, splintery Brittle	4. 4.4	Usually with other iron minerals; in cavities in hematite or limonite.
Yellowish brown	C—Clinopinacoidal, perfect, conspicuous Brittle	6.7 7.3	Structure, cleavage, and specific gravity characteristic. In quartz veins. With wolframite, fluorite, scheelite, galena, tetrahedrite.
Dark reddish brown	C—Clinopinacoidal, perfect, conspicuous F—Uneven Brittle	7.1 7.5	Distinguished from huebnerite by streak. Powder may be slightly magnetic. With cassiterite, quartz, mica, scheelite, molybdenite, huebnerite.
Yellowish Brownish	C—Prismatic, pyramidal, not conspicuous F—Uneven Brittle	4.2 4.3	Not as heavy as cassiterite. Often in fine, hair-like inclusions. Widely distributed. With quartz, feldspars, hematite, ilmenite, chlorite, brookite.

Streak—Pink, red, brown, or yellow

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
CASSITERITE SnO_2 or $SnSnO_4$	Tetragonal **C**—Thick prismatic; knee-shaped twins quite common **M**—Compact, reniform, botryoidal, rounded pebbles, often with radial fibrous structure (*wood tin*)	Adamantine Dull Translucent to opaque	Brownish Yellowish

Streak—Uncolored, white, or light gray

Carnallite $MgCl_2.KCl.6H_2O$	Orthorhombic **C**—Apparently hexagonal, rare **M**—Compact, granular	Vitreous Dull Transparent to translucent	Reddish
Laumontite (Zeolite) $Ca(Al.2OH)_2(Si_2O_5)_2.2H_2O$	Monoclinic **M**—Earthy, powdery	Dull Opaque	Pink Red
***KAOLINITE** (Kaolin) $H_4Al_2Si_2O_9$	Monoclinic **C**—Scaly, with hexagonal outline, rare **M**—Compact, friable, clay-like	Dull Pearly Opaque to translucent	Reddish
* **TALC,** varieties *Foliated* *Soapstone* $H_2Mg_3Si_4O_{12}$	Monoclinic **C**—Thin tabular, indistinct **M**—Foliated, globular, fibrous, granular, compact	Greasy Pearly Translucent to opaque	Reddish
GYPSUM $CaSO_4.2H_2O$	Monoclinic **C**—Rare **M**—Coarse, fine granular, fibrous, cleavable, sand	Vitreous Silky Dull Transparent to opaque	Flesh red Brick red

* Uncommon color.

Hardness over 3

Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
Pale yellow Pale brown	**C**—Indistinct **F**—Uneven Brittle	6.8 7.	Recognized by high specific gravity. In veins cutting granite, gneiss; in alluvial deposits as *stream tin*. With quartz, mica, wolframite, scheelite, arsenopyrite, tourmaline, fluorite, apatite, chlorite.

Hardness 1 to 3

White	**C**—Indistinct **F**—Conchoidal Brittle	1.6	Color due to hematite or gœthite. Bitter taste; absorbs moisture. With halite, kieserite, kainite, sylvite, anhydrite.
White	**F**—Earthy Friable	2.3	Harder when fresh and unexposed. In cavities and fissures in basic igneous rocks. With stilbite, apophyllite, analcite, native copper.
White Yellowish white Reddish white	**C**—Basal (scales) **F**—Earthy, conspicuous Brittle	2.2 2.6	Clay odor when breathed upon. Usually adheres to tongue and becomes plastic when moistened. Greasy feel. With quartz, feldspar, corundum, diaspore.
White Reddish white	**C**—Basal, perfect, conspicuous when foliated **F**—Uneven, splintery Sectile, laminæ flexible	2.6 2.8	Greasy or soapy feel important. *Foliated*, easily separable, inelastic plates, H=1; *soapstone* or *steatite*, coarse to fine granular, more or less impure, H up to 2.5. With serpentine, chlorite, dolomite, magnesite, actinolite.
White	**C**—Clinopinacoidal, perfect conspicuous; pyramidal, orthopinacoidal (crystals) **F**—Conchoidal Brittle, laminæ flexible	2.2 2.4	Ferruginous gypsum. In limestones, shales. With halite, celestite, sulphur, aragonite, anhydrite, ore deposits.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Amber (Succinite) $C_{40}H_{64}O_4$	Amorphous **M**—Irregular, stalactitic, grains and lumps	Greasy Transparent to translucent	Brownish Yellowish
Sylvite KCl	Cubic **C**—Cubes, alone or with octahedron **M**—Granular, compact	Vitreous Transparent to translucent	Red Yellowish
Halite (Rock salt) NaCl	Cubic **C**—Cubes, often skeletal or hopper-shaped, rare **M**—Compact, cleavable, granular, fibrous, crusts, stalactitic	Vitreous Transparent to translucent	Red Reddish Purplish
Lepidolite (Lithium mica) $(Li,H)_2(F,OH)_2Al_2Si_3O_9$	Monoclinic **C**—Short prismatic **M**—Granular, coarse or fine; scales, cleavable plates	Pearly Translucent	Pink Rose red Red viole
Glauberite $Na_2SO_4.CaSO_4$	Monoclinic **C**—Thick tabular **M**—Reniform, lamellar	Vitreous Greasy Transparent to translucent	Flesh red Brick red
Kainite $MgSO_4.KCl.3H_2O$	Monoclinic **C**—Tabular, prismatic, rare **M**—Compact, fine granular	Vitreous Transparent to translucent	Flesh red Brick red
***Gibbsite** (Hydrargillite) $Al(OH)_3$	Monoclinic **C**—Tabular, pseudohexagonal, rare **M**—Stalactitic, mammillary, surface smooth, internal structure fibrous	Vitreous Pearly Translucent	Reddish

* Uncommon color.

Hardness 1 to 3

Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
White	**F**—Conchoidal Brittle	1. 1.1	Fossil resin. Electrified when rubbed. Often mottled and striped. Sometimes contains inclusions—insects, vegetable remains, liquids, minerals.
White	**C**—Cubic **F**—Conchoidal Brittle	1.9 2.	Color due to impurities. Salty bitter taste. May absorb moisture and become damp. Usually in salt deposits. With halite, kainite, carnallite.
White	**C**—Cubic, perfect, conspicuous **F**—Conchoidal Brittle	2.1 2.3	Characteristic cubical cleavage and saline taste. Color due to impurities. May absorb moisture and become damp. With shale, gypsum, anhydrite, polyphalite.
White	**C**—Basal, perfect **F**—Scaly, granular Tough	2.8 2.9	When massive may resemble granular limestone. In pegmatites, granites, gneisses. With red tourmaline (rubellite), amblygonite, spodumene, topaz.
White	**C**—Basal, perfect **F**—Conchoidal Brittle	2.7 2.8	Bitter saline taste. On exposure becomes coated with white powdery crust. With halite, thenardite, mirabilite.
White	**C**—Pinacoidal, prismatic, not conspicuous **F**—Uneven Brittle	2. 2.2	Taste, salty, bitter, and astringent. Non-hygroscopic. With halite, sylvite.
White	**C**—Basal, not conspicuous Tough	2.3 2.4	Slight clay odor when breathed upon. With bauxite, natrolite, limonite, corundum.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
PHLOGOPITE (Bronze mica) $(K,H)_3Mg_3Al(SiO_4)_3$	Monoclinic **C**—Tabular, prismatic, hexagonal or orthorhombic outline, often large and coarse **M**—Plates, disseminated scales	Pearly Submetallic Transparent to translucent	Copper red Bronze red Brownish r
***CRYOLITE** Na_3AlF_6	Monoclinic **C**—Pseudocubical, small, rare **M**—Cleavable, granular	Vitreous Greasy Transparent to translucent	Reddish Brownish r Brick red
***BARITE** (Heavy spar) $BaSO_4$	Orthorhombic **C**—Tabular, prismatic, very common; crested divergent groups **M**—Compact, lamellar, fibrous, cleavable, reniform	Vitreous Pearly Transparent to opaque	Reddish Red
CALCITE $CaCO_3$	Hexagonal **C**—Scalenohedral, rhombohedral, prismatic, tabular, often highly modified and twinned **M**—Cleavable, granular, fibrous, compact	Vitreous Dull Transparent to nearly opaque	Pink Red Violet Amethysti
Wulfenite $PbMoO_4$	Tetragonal **C**—Square, thin tabular, more rarely pyramidal **M**—Coarse to fine granular	Greasy Adamantine Transparent to translucent	Orange red Bright red

* Uncommon color.

Hardness 1 to 3

Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
White	**C**—Basal, perfect, conspicuous Tough, laminæ very elastic	2.8 3.	When cleavage laminæ are held close to the eye in viewing a source of light, a star-like form is sometimes observed. Especially characteristic of crystalline limestones, dolomites, schists. With pyroxenes, amphiboles, serpentine.
White	**C**—Basal, prismatic, perfect, nearly 90°, sometimes conspicuous **F**—Uneven Brittle	2.9 3.	Often contains disseminated siderite, chalcopyrite, galena, sphalerite, fluorite, columbite.
White	**C**—Basal, prismatic, conspicuous **F**—Uneven Brittle	4.3 4.7	Characterized by rather high specific gravity and cleavages. In metalliferous veins; pockets and lenticular masses in limestones. With galena, sphalerite, fluorite, chalcopyrite; manganese and iron minerals.
White	**C**—Rhombohedral, perfect, very conspicuous **F**—Conchoidal Brittle	2.7	Rhombohedral cleavage characteristic, especially on crystals. Cleavages often show striations. Very strong double refraction observed when transparent.
White Yellowish white	**C**—Pyramidal, indistinct **F**—Conchoidal, uneven Brittle	6.3 7.	Square plates, sometimes with forms of the third order. With lead minerals—galena, pyromorphite, vanadinite.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Vanadinite $Pb_5Cl(VO_4)_3$	Hexagonal **C**—Prismatic, small, at times skeletal **M**—Compact, globular, fibrous, crusts	Greasy Translucent to opaque	Ruby red Orange re Brownish

Streak—Uncolored, white, or light gray

Gibbsite (Hydrargillite) $Al(OH)_3$	Monoclinic **C**—Tabular, pseudohexagonal, rare **M**—Stalactitic, mammillary, surface smooth, internal structure fibrous	Vitreous Pearly Translucent	Reddish
Polyhalite $K_2MgCa_2(SO_4)_4.2H_2O$	Monoclinic ? **C**—Indistinct **M**—Compact, fibrous, lamellar	Greasy Pearly Translucent	Flesh red Brick red
***ANHYDRITE** $CaSO_4$	Orthorhombic **C**—Thick tabular, prismatic, rare **M**—Granular, compact, fibrous, lamellar, cleavable	Vitreous Pearly Translucent to opaque	Reddish Brick red
***CELESTITE** $SrSO_4$	Orthorhombic **C**—Tabular, prismatic, common **M**—Compact, cleavable, fibrous, granular, reniform	Vitreous Pearly Transparent to translucent	Reddish Brick red
***BARITE** (Heavy spar) $BaSO_4$	Orthorhombic **C**—Tabular, prismatic, very common; crested divergent groups **M**—Compact, lamellar, fibrous, cleavable, reniform	Vitreous Pearly Transparent to opaque	Reddish Red

* Uncommon color.

Hardness 1 to 3

rd-ss	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
.	White Yellowish white	C—None F—Conchoidal, uneven Brittle	6.7 7.2	Crystal faces smooth with sharp edges. With lead minerals but never in large quantities.

Hardness 3 to 6

. .5	White	C—Basal, not conspicuous Tough	2.3 2.4	Slight clay odor when breathed upon. With bauxite, natrolite, limonite, corundum.
. .5	White Reddish white Yellowish white	F—Stalky, fibrous Brittle	2.7 2.8	Taste, bitter and astringent, but weak. With halite, anhydrite, clay.
. .5	White	C—Pinacoidal, perfect, 3 directions at 90°, sometimes conspicuous F—Conchoidal Brittle	2.8 3.	Granular varieties resemble marble. Not as heavy as celestite or barite. In limestones, shales. With halite, gypsum.
. .5	White	C—Basal, prismatic, conspicuous F—Uneven Brittle	3.9 4.	Heavier than calcite, anhydrite; lighter than barite. In limestones, dolomites, shales. With gypsum, aragonite, halite, galena, sphalerite.
. .5	White	C—Prismatic, conspicuous F—Uneven Brittle	4.3 4.7	Characterized by rather high specific gravity and cleavages. In metalliferous veins; pockets and lenticular masses in limestones. With galena, sphalerite, fluorite, chalcopyrite; manganese and iron minerals.

Streak—Uncolored, white, or light gray

	Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
ZEOLITES	**Stilbite** (Desmine) $(Ca,Na_2)Al_2Si_6O_{16}.6H_2O$	Monoclinic **C**—Twinned in sheaf-like, radial, or globular aggregates	Vitreous Pearly Transparent to translucent	Pale red Brick red
	Heulandite $H_4CaAl_2(SiO_3)_6.3H_2O$	Monoclinic **C**—Tabular, striated **M**—Foliated, granular, globular	Vitreous Pearly Transparent to translucent	Flesh red Brick red
	Laumontite $Ca(Al.2OH)_2(Si_2O_5)_2.2H_2O$	Monoclinic **C**—Columnar **M**—Radial, divergent, earthy	Vitreous Dull Transparent to opaque	Pink Red
	***SERPENTINE** $H_4Mg_3Si_2O_9$	Monoclinic **C**—Unknown **M**—Compact, columnar, fibrous, lamellar, granular	Greasy Waxy Translucent to opaque	Brownish re Red
	Lepidolite (Lithium mica) $(Li,H)_2(F,OH)_2Al_2Si_3O_9$	Monoclinic **C**—Short prismatic **M**—Granular, coarse or fine; scales, cleavable plates	Pearly Translucent	Pink Rose red Red violet
	Margarite $H_2CaAl_4Si_2O_{12}$	Monoclinic **C**—Six-sided plates **M**—Scaly, foliated, granular	Pearly Vitreous Translucent	Pink Rose red
	ALUNITE (Alum stone) $K_2(Al.2OH)_6(SO_4)_4$	Hexagonal **C**—Rhombohedrons, resembling cubes, tabular, rare **M**—Compact, granular, fibrous, earthy	Vitreous Pearly Transparent to translucent	Pink Reddish white
	***DOLOMITE** $CaMg(CO_3)_2$	Hexagonal **C**—Rhombohedral with curved surfaces **M**—Coarsely crystalline, compact, friable	Vitreous Transparent to translucent	Pink Reddish

* Uncommon color.

Hardness 3 to 6

rd-ss	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
	White	C—Pinacoidal F—Uneven Brittle	2.1 2.2	Radial and sheaf-like structure. In basic igneous rocks. With chabazite, apophyllite, heulandite, datolite, calcite.
	White	C—Clinopinacoidal, perfect F – Uneven Brittle	2.1 2.2	In basic igneous rocks and metalliferous veins. With chabazite, stilbite, apophyllite, datolite.
	White	C – Clinopinacoidal, prismatic F—Uneven, earthy Brittle, friable	2.3	On exposure becomes dull and crumbles to powder. In cavities and fissures in basic igneous rocks. With stilbite, apophyllite, analcite, copper, epidote.
	White	F—Conchoidal, splintery Brittle	2.5 2.8	Smooth and greasy feel. Often spotted, clouded, multicolored. Color due to ferric oxide. With magnesite, calcite, chromite, garnierite, pyrope, platinum.
	White	C—Basal, perfect F—Scaly, granular Tough	2.8 2.9	When massive often resembles granular limestone. In pegmatites, granites, gneisses. With red tourmaline (rubellite), amblygonite, spodumene, topaz.
5	White	C—Basal, perfect, conspicuous F—Scaly, granular Brittle	3.	Resembles mica in structure and cleavage, but harder, laminæ brittle and inelastic. With chlorite, corundum, emery, diaspore.
5	White	C—Basal F—Splintery, conchoidal, earthy Brittle	2.6 2.8	Hardness often greater due to admixture of quartz, feldspar; then tough. Deposits and veins in feldspathic rocks. With kaolin, pyrite, opal.
5	White Gray	C—Rhombohedral, perfect F—Conchoidal Brittle	2.9	Crystals generally curved or saddle-shaped. *Marble* includes some compact varieties. In independent beds; ıssures, and cavities; with ore deposits.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
*ARAGONITE $CaCO_3$	Orthorhombic **C**—Chisel- or spear-shaped; pseudohexagonal prisms; radial, columnar or acicular aggregates **M**—Stalactitic, reniform, crusts, oolitic	Vitreous Greasy Transparent to translucent	Reddish Brick red
SPHALERITE ZnS	Cubic **C**—Tetrahedral, common **M**—Cleavable, fine or coarse granular, compact	Resinous Submetallic Translucent to opaque	Brownish re Yellowish re
RHODOCHROSITE $MnCO_3$	Hexagonal **C**—Rhombohedral, rare **M**—Cleavable, granular, compact, botryoidal, crusts	Vitreous Translucent	Rose red Brownish re Pink
FLUORITE (Fluor spar) CaF_2	Cubic **C**—Cubes, alone or modified, well developed, common; penetration twins **M**—Cleavable, granular, fibrous	Vitreous Transparent to nearly opaque	Red violet Pink Rose red
ZEOLITES CHABAZITE $CaAl_2Si_6O_{16}.8H_2O$, etc.	Hexagonal **C**—Rhombohedral, cube-like, lenticular **M**—Compact	Vitreous Translucent to transparent	Flesh red Red
ZEOLITES *Harmotome $BaAl_2Si_6O_{16}.6H_2O$, etc.	Monoclinic **C**—Usually twins, penetrating at 90°	Vitreous Translucent	Reddish
*Xenotime YPO_4	Tetragonal **C**—Pyramidal, prismatic **M**—Compact, disseminated, rolled grains	Greasy Vitreous Translucent to opaque	Flesh red Brownish re Yellowish re

* Uncommon color.

Hardness 3 to 6

rd-ss	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
.5 .	White Gray	C—Brachypinacoidal, prismatic F—Conchoidal Brittle	2.9 3.	Twins common, often pseudo-hexagonal (prism and striated base). In cracks and cavities, disseminated; with ore deposits; deposition from hot springs; in shells. With gypsum, celestite, sulphur, siderite, zeolites.
.5 .	Gray Yellowish white	C—Dodecahedral, perfect, usually conspicuous F—Conchoidal Brittle	3.9 4.2	Color and streak vary with impurities. Extensively in limestones. With galena, chalcopyrite, pyrite, barite, fluorite, rhodochrosite, smithsonite.
.5 .5	White	C—Rhombohedral, perfect, conspicuous F—Uneven Brittle	3.3 3.6	May turn brown to black on exposure, due to MnO_2. With galena, sphalerite, pyrite, alabandite, rhodonite, psilomelane, silver minerals.
.	White	C—Octahedral, perfect, conspicuous Brittle	3. 3.2	Easily recognized by crystal form, cleavage, and hardness. Common gangue mineral of metallic ores. With galena, sphalerite, cassiterite, calcite, quartz, barite.
. .	White	C—Rhombohedral, not conspicuous F—Uneven Brittle	2.1 2.2	Generally in cube-like crystals. Inferior cleavage distinguishes it from fluorite and calcite. In basic igneous rocks. With analcite, stilbite, harmotome, heulandite.
. .	White	C—Pinacoidal F—Uneven Brittle	2.4 2.5	Cruciform twins. In basic igneous rocks and metalliferous veins. With chabazite, calcite, adularia, quartz. *Phillipsite*, contains calcium replacing barium.
. . .	Yellowish white Brownish white Reddish white	C—Prismatic F—Uneven, splintery Brittle	4.4 4.6	Commonly as loose, disseminated, or attached crystals resembling zircon, but softer. In granite, gneiss. With zircon; alluvial deposits.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
*Scheelite $CaWO_4$	Tetragonal C—Pyramidal, small; tabular M—Drusy crusts, reniform, granular, disseminated, compact	Adamantine Greasy Transparent to translucent	Hyacinth red Reddish
APOPHYLLITE (Zeolite) $H_{14}K_2Ca_8(SiO_3)_{16}.9H_2O$	Tetragonal C—Prismatic, pyramidal, pseudocubical, tabular M—Lamellar, granular, compact	Vitreous Pearly Transparent to nearly opaque	Pale red Flesh red Rose red
*Wollastonite, (Pyroxene, tabular spar) $CaSiO_3$	Monoclinic C—Tabular, prismatic M—Cleavable, fibrous, granular, compact	Vitreous Silky Transparent to translucent	Reddish
APATITE $Ca_5F(PO_4)_3$	Hexagonal C—Prismatic, thick tabular, common, sometimes large with rounded edges M—Compact, fibrous, nodular, reniform	Greasy Vitreous Translucent to opaque	Violet red Brownish red Red
Huebnerite $MnWO_4$	Monoclinic C—Long fibrous, bladed, stalky; often divergent, without good terminations M—Compact, lamellar, granular	Resinous Submetallic Translucent to opaque	Brownish red

*Uncommon color.

Hardness 3 to 6

ard-ess	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
4.5	White	C—Pyramidal F—Conchoidal, uneven Brittle	5.9 6.2	Small, well developed octahedral-like crystals, usually on quartz; when massive, high specific gravity important. With wolframite, cassiterite, fluorite, topaz, molybdenite.
4.5 5.	White	C—Basal, perfect, conspicuous F—Uneven Brittle	2.3 2.4	Prism faces vertically striated. In fissures and cavities in basic igneous rocks. With natrolite, analcite, laumontite, datolite, pectolite, native copper, calcite.
4.5 5.	White	C—Basal, orthopinacoidal F—Uneven Brittle	2.8 2.9	Fibers may be parallel or divergent. Typical contact mineral. Often in crystalline limestone, with garnet, diopside, vesuvianite, epidote, graphite.
4.5 5.	White Reddish white	C—Basal, imperfect F—Conchoidal, uneven Brittle	3.1 3.2	Crystals may be vertically striated and have fused appearance. Color often unevenly distributed, —mottled brown and green. In crystalline limestones, metalliferous ore deposits, igneous rocks. With quartz, cassiterite, fluorite, wolframite, magnetite.
4.5 5.5	Greenish gray	C—Clinopinacoidal, perfect, conspicuous Brittle	6.7 7.3	Structure, cleavage, and specific gravity characteristic. In quartz veins. With wolframite, fluorite, pyrite, scheelite, galena, tetrahedrite.

Streak—Uncolored, white, or light gray

	Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
ZEOLITES	**ANALCITE** $Na_2Al_2(SiO_3)_4 . 2H_2O$	Cubic **C**—Tetragonal trisoctahedrons, cubes **M**—Granular, compact	Vitreous Translucent to opaque	Reddish Brick red
ZEOLITES	***Natrolite** $Na_2Al(AlO)(SiO_3)_3 . 2H_2O$	Orthorhombic **C**—Slender prismatic, nearly square, radial or interlacing groups **M**—Fibrous, granular, compact	Vitreous Silky Transparent to translucent	Reddish
ZEOLITES	***Thomsonite** $2(Ca,Na_2)Al_2(SiO_4)_2 . 5H_2O$	Orthorhombic **C**—Prismatic, vertically striated, divergent groups **M**—Fibrous, columnar, radial; spherical concretions	Vitreous Silky Pearly Translucent to transparent	Reddish
	Datolite $Ca(B . OH)SiO_4$	Monoclinic **M**—Compact, fibrous, granular, botryoidal	Vitreous Greasy Dull Translucent to opaque	Pink Red Red violet
	TITANITE (Sphene) $CaTiSiO_5$	Monoclinic **C**—Wedge- or envelope-shaped when disseminated; tabular or prismatic when attached **M**—Compact, lamellar	Vitreous Greasy Transparent to opaque	Brownish re Red
	Monazite $(Ce,La,Di)PO_4$	Monoclinic **C**—Thick tabular, square prismatic **M**—Angular, rolled grains	Resinous Vitreous Translucent to opaque	Hyacinth re Brownish re

* Uncommon color.

Hardness 3 to 6

rd-ess	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
. .5	White Reddish white	C—None F—Uneven, conchoidal Brittle	2.2 2.3	Good crystals common. In fissures and cavities in basic igneous rocks. With apophyllite, chabazite, natrolite, laumontite, datolite, native copper, prehnite, epidote.
. .5	White	C—Prismatic F—Uneven Brittle	2.2 2.3	Crystals have nearly square cross-section. With chabazite, analcite, apophyllite, stilbite, prehnite, datolite.
. .5	White	C—Pinacoidal F—Uneven Brittle	2.3 2.4	When massive, radial fibrous, often mottled or banded. In fissures and cavities in basic igneous rocks. With stilbite, analcite, prehnite, calcite.
. .5	White	C—None F—Conchoidal, uneven Brittle	2.9 3.	Compact masses often with brownish, yellowish, or whitish streaks and spots. In cracks and cavities in basic igneous rocks. With calcite, prehnite, epidote, native copper, zeolites.
. .5	White Gray	C—Prismatic, conspicuous parting often noted F—Conchoidal Brittle	3.4 3.6	With feldspars, pyroxenes, amphiboles, chlorite, scapolite, zircon.
. .5	White	C—Basal F—Conchoidal, uneven Brittle	4.9 5.3	Crystals commonly small, highly modified, or as rolled grains in sand. With magnetite, zircon, garnet, thorite, gold, chromite, diamond.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
*Sodalite $Na_4Al_2(AlCl)(SiO_4)_3$	Cubic C—Dodecahedrons M—Compact, disseminated grains, nodular	Vitreous Greasy Transparent to translucent	Pink Reddish
*Cancrinite $H_6(Na_2,Ca)_4(NaCO_3)_2Al_3Si_9O_{36}$	Hexagonal C—Prismatic, rare M—Compact, lamellar, columnar, disseminated	Greasy Vitreous Transparent to translucent	Reddish Rose red
NEPHELITE (Nepheline, elaeolite) $(Na,K)_3Al_3Si_9O_{34}$	Hexagonal C—Short prismatic, tabular M—Compact, disseminated grains	Greasy Vitreous Transparent to opaque	Reddish Brownish r Brick red
SCAPOLITE (Wernerite) $\{ n Na_4Al_3Si_9O_{24}Cl$ $\{ m Ca_4Al_6Si_6O_{25}$	Tetragonal C—Prismatic M—Compact, granular, fibrous, columnar	Vitreous Greasy Translucent	Pink Red violet Brick red
Tremolite (Amphibole), variety *Hexagonite* $Ca_2Mg_5H_2(SiO_3)_8$	Monoclinic M—Columnar, fibrous, acicular	Vitreous Transparent to translucent	Pink Red violet Lavender
RHODONITE (Pyroxene) $MnSiO_3$	Triclinic C—Tabular, prismatic, rounded edges, often large M—Compact, cleavable, granular, disseminated grains	Vitreous Dull Transparent to opaque	Brownish r Flesh red Rose red
Willemite (Troostite) Zn_2SiO_4	Hexagonal C—Prismatic M—Compact, granular, disseminated grains	Greasy Vitreous Transparent to opaque	Flesh red Brownish r

* Uncommon color.

Hardness 3 to 6

rd-ss	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
	White	C—Dodecahedral F—Conchoidal, uneven Brittle	2.2 2.4	Recognized by associates—nephelite, cancrinite, leucite, feldspar, zircon; not with quartz.
	White	C—Prismatic, perfect F—Uneven Brittle	2.4 2.5	Typical associates — nephelite, sodalite, biotite, feldspar, titanite.
	White	C—Indistinct F—Conchoidal, uneven Brittle	2.6	Distinguished from orthoclase by inferior cleavage, and more greasy luster. With feldspars, cancrinite, biotite, sodalite, zircon, leucite, corundum; not with quartz.
	White	C—Prismatic, not conspicuous F—Conchoidal Brittle	2.6 2.8	Often resembles pink fluorite in color, but cleavage less distinct, and harder. In metamorphic rocks, especially granular limestones. With pyroxenes, apatite, garnet, titanite, biotite, amphiboles.
	White	C—Prismatic, Brittle	2.9 3.1	Masses of delicate, interwoven fibers with characteristic pinkish color.
	White Reddish white	C—Prismatic, basal F—Conchoidal, uneven Tough, when massive; crystals brittle	3.4 3.7	May be stained brown to black on exposure. *Fowlerite*, variety containing zinc. With franklinite, zincite, willemite, calcite, tetrahedrite.
	White	C—Basal, prismatic F—Uneven Brittle	3.9 4.3	Crystals of willemite small, those of *troostite*—manganiferous variety—often large. Characterized by associates—franklinite, zincite, rhodonite, calcite.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
OPAL, varieties *Fire opal* *Opal jasper* $SiO_2.nH_2O$	Amorphous **M**—Reniform, botryoidal, stalactitic, compact	Vitreous Greasy Transparent to opaque	Red Brownish re

Streak—Uncolored, white, or light gray

	Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
FELDSPARS	**ORTHOCLASE** $KAlSi_3O_8$	Monoclinic **C**—Prismatic, thick tabular; twins; often large **M**—Cleavable, granular, disseminated	Vitreous Pearly Translucent to opaque	Flesh red Brick red
FELDSPARS	Oligoclase (Plagioclase) $Ab.....Ab_3An_1$ (See page 242)	Triclinic **C**—Tabular, rare **M**—Compact, cleavable, granular	Vitreous Pearly Greasy Transparent to translucent	Flesh red Brick red
	Chondrodite $[Mg(F,OH)]_2Mg_3(SiO_4)_2$	Monoclinic **C**—Small, highly modified, rare **M**—Rounded grains; compact	Vitreous Greasy Translucent to opaque	Brownish re Dark red
	Zoisite, variety *Thulite* $Ca_2Al_2(Al.OH)(SiO_4)_3$	Orthorhombic **C**—Prismatic, deeply striated, bent, without good terminations **M**—Columnar, broad bladed, fibrous	Vitreous Transparent	Rose red
	***EPIDOTE** $Ca_2(Al,Fe)_2(Al.OH)(SiO_4)_3$	Monoclinic **M**—Columnar, fibrous, parallel and divergent; granular	Vitreous Transparent to opaque	Red

* Uncommon color.

Hardness 3 to 6

ard- ness	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
5.5 6.	White	F—Conchoidal, conspicuous Brittle	2.1 2.3	Structure and fracture characteristic. *Fire opal*, transparent to translucent and red; *opal jasper*, greasy and opaque, resembling jasper. In veins, cavities, and masses of irregular outline.

Hardness over 6

6. 6.5	White	C—Basal, clinopinacoidal, perfect, conspicuous—90° F—Conchoidal, uneven Brittle	2.5 2.6	Characterized by rectangular cleavage and absence of twinning striations. In granitic rocks. With quartz, other feldspars, mica, hornblende, zircon.
6. 6.5	White	C—Basal, brachypinacoidal, conspicuous, 86° 32′ F—Uneven Brittle	2.7	Commonly glassy with inclined cleavages showing parallel striations. In granitic rocks. With quartz, other feldspars, mica, garnet, tourmaline. *Aventurine oligoclase* or *sunstone*, contains disseminated scales yielding yellowish or reddish reflections.
6. 6.5	White	C—Basal F—Conchoidal, uneven Brittle	3.1 3.3	Associates important. Disseminated chiefly in crystalline limestones and dolomites. With spinel, vesuvianite, pyroxenes, magnetite, mica.
6. 6.5	White	C—Brachypinacoidal, conspicuous F—Uneven Brittle	3.3 3.4	Deeply furrowed and transversely broken, columnar, masses. In crystalline schists. With hornblende, vesuvianite, epidote, garnet, feldspars.
6. 7.	White Grayish	C—Basal, perfect F—Uneven Brittle	3.3 3.5	With quartz, feldspar, garnet, vesuvianite, hornblende, pyroxene, magnetite.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
RUTILE TiO_2 or $TiTiO_4$	Tetragonal **C**—Prismatic, vertically striated; knee-shaped or rosette twins **M**—Compact, disseminated	Adamantine Submetallic Translucent to opaque	Dark red Brownish red
CASSITERITE SnO_2 or $SnSnO_4$	Tetragonal **C**—Thick prismatic; knee-shaped twins quite common **M**—Compact, reniform, botryoidal, rounded pebbles	Adamantine Resinous Dull Translucent to opaque	Brownish red Yellowish red
ANDALUSITE Al_2SiO_5	Orthorhombic **C**—Prismatic, rough, nearly square, often large and without terminations **M**—Columnar, fibrous, granular	Vitreous Dull Translucent to opaque	Pink Rose red Red violet
***OLIVINE** $(Mg,Fe)_2SiO_4$	Orthorhombic **C**—Prismatic, thick tabular **M**—Rounded, disseminated glassy grains; granular aggregates	Vitreous Dull Translucent to transparent	Brownish red Yellowish red
GARNET, varieties $M_3''M_2'''(SiO_4)_3$ $M'' = Ca,Fe,Mg$ $M''' = Al,Fe$	Cubic *Grossularite* *Pyrope* *Spessartite* *Almandite* *Andradite* **C**—Dodecahedron, tetragonal trisoctahedrons, alone or in combination **M**—Granular, compact, lamellar, disseminated, sand	Vitreous Transparent to opaque	Rose red Ruby red Brownish red Dark red

* Uncommon color.

Hardness over 6

Hardness	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
6. 7.	Gray Yellowish white Brownish white	C—Prismatic, pyramidal, not conspicuous F—Uneven Brittle	4.2 4.3	Not as heavy as cassiterite. Often as fine hair-like inclusions. Widely distributed. With quartz, feldspar, hematite, ilmenite, chlorite, brookite.
6. 7.	White Yellowish white Brownish white	C—Indistinct F—Uneven Brittle	6.8 7.	High specific gravity. In veins cutting granite, gneiss; in alluvial deposits as *stream tin*, with internal fibrous structure, *wood tin*. With quartz, mica, wolframite, scheelite, arsenopyrite, tourmaline, fluorite, chlorite.
6. 7.5	White	C—Prismatic F—Uneven Brittle	3.1 3.2	Due to alteration, surface may be covered with scales of mica and, hence, is softer. In metamorphic rocks often as rounded or knotty projections. With cyanite, sillimanite, garnet, tourmalene.
6.5 7.	White Brownish white Yellowish white	C—Pinacoidal, indistinct F—Conchoidal Brittle	3.2 3.6	In basic igneous rocks—basalts, traps; crystalline limestones. With augite, magnetite, spinel, plagioclase, chromite, pyrope.
6.5 7.5	White Gray	C—Dodecahedral, indistinct F—Conchoidal, uneven Brittle	3.4 4.3	*Grossularite*, in crystalline limestones and dolomites, with wollastonite, vesuvianite, diopside, scapolite; *pyrope*, rounded grains, in serpentine; *spessartite*, in granitic rocks, with topaz, tourmaline, quartz, orthoclase; *almandite*, with mica, staurolite, andalusite, cyanite; *andradite*, with magnetite, epidote, feldspar, nephelite, leucite.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster . Transparency	Color
QUARTZ, Crystalline varieties SiO_2 *Amethyst* *Rose quartz* *Aventurine* *Ferruginous*	Hexagonal **C**—Prismatic, horizontally striated, common **M**—Compact, granular	Vitreous Greasy Transparent to opaque	Red violet Rose red Brick red Brownish red
Cryptocrystalline varieties *Carnelian* *Agate* *Sardonyx* *Jasper* *Heliotrope*	Hexagonal **C**—Never in crystals **M**—Banded, spotted, compact	Waxy Vitreous Translucent to opaque	Bright red Dark red Brownish red
Clastic varieties *Sand* *Sandstone* *Quartzite*	Hexagonal Loose or strongly consolidated grains or fragments	Vitreous Dull Translucent to opaque	Red Brownish red Purplish red
DUMORTIERITE $HBAl_8Si_3O_{20}$	Orthorhombic **C**—Prismatic, pseudohexagonal, small **M**—Fibrous, columnar	Vitreous Silky Transparent to translucent	Pink Red violet
TOURMALINE, variety *Rubellite* $M'_{20}B_2Si_4O_{21}$ M′ = Na,K,Li,Mg, Ca,(OH),Fe, Al	Hexagonal **C**—Prismatic, often vertically striated, rarely with good terminations **M**—Divergent, columnar, compact	Vitreous Transparent to translucent	Pink Rose red Ruby red
Spodumene (Pyroxene), variety $LiAl(SiO_3)_2$ *Kunzite*	Monoclinic **C**—Prismatic, tabular, sometimes large **M**—Cleavable, broad columnar	Vitreous Transparent	Pink Lilac Amethystine

Hardness over 6

ard-ess	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
.	White Reddish white	C—Indistinct F—Conchoidal, conspicuous Brittle	2.6	Characteristic conchoidal fracture and glassy luster. *Amethyst*, usually in crystals, purple or blue violet; *rose quartz*, usually massive, pink to rose red; *aventurine*, massive and glistening, due to included scales; *ferruginous quartz*, colored by iron oxide.
.	White Reddish white	C—Indistinct F—Conchoidal, conspicuous Brittle to tough	2.6	Not as glassy as crystalline varieties. *Carnelian*, *jasper*, uniform in color; *agate*, *sardonyx*, banded; *heliotrope*, spotted.
.	White Reddish white	C—Indistinct F—Uneven Brittle to tough	2.6	Pigment is usually ferruginous matter. *Sand*, loose unconsolidated grains; *sandstone*, consolidated sand; *quartzite*, metamorphosed sandstone.
.	White	C—Pinacoidal, distinct F—Conchoidal Brittle	3.3	In pegmatites, veins, and lenticular masses. With quartz, muscovite, andalusite, cyanite. At times in radial aggregates.
. .5	White	C—None F—Conchoidal, uneven Brittle	2.9 3.2	Spherical triangular cross-section. Often with zonal distribution of color—red, green, colorless. Frequently as long, divergent, columnar masses imbedded in lepidolite.
. .5	White	C—Prismatic, perfect; pinacoidal parting, conspicuous F—Uneven, conchoidal Brittle	3.1 3.2	Commonly in broad plates, due to distinct pinacoidal parting. Prism angle 93°. In granitic rocks. With tourmaline, lepidolite, beryl.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
*Phenacite Be_2SiO_4	Hexagonal C—Rhombohedral, pyramidal, lenticular, highly modified	Vitreous Transparent to translucent	Rose red
ZIRCON $ZrSiO_4$	Tetragonal C—Prismatic, pyramidal, small, well developed M—Irregular lumps, grains	Adamantine Vitreous Resinous Transparent to opaque	Brownish red Dark red
BERYL, variety *Morganite* $Be_3Al_2(SiO_3)_6$	Hexagonal C—Long prismatic, often vertically striated, large M—Columnar, granular, compact	Vitreous Transparent to translucent	Pale pink Rose red
*TOPAZ $Al_2(F,OH)_2SiO_4$	Orthorhombic C—Prismatic, vertically striated, highly modified M—Compact, granular, rounded fragments	Vitreous Transparent to opaque	Pink Red Red violet
SPINEL, varieties *Balas* $M''(M'''O_2)_2$ *Ruby* $M'' = Mg,Fe,Mn$ *Rubicelle* $M''' = Al,Fe$ *Almandine*	Cubic C—Octahedral, twins, small M—Rounded grains, small pebbles	Vitreous Splendent Transparent to translucent	Deep red Rose red Orange red Bluish red
CORUNDUM, varieties *Ruby* Al_2O_3 *Oriental amethyst* *Common*	Hexagonal C—Prismatic, tabular, pyramidal, rhombohedral, rough and rounded barrel-shaped M—Compact, granular, lamellar	Vitreous Transparent to translucent	Pink Red Red violet

* Uncommon color.

Hardness over 6

ard- ess	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
7. 8.	White	C—Prismatic, indistinct F—Conchoidal Brittle	3.	Distinguished from quartz and topaz by crystal form and cleavage. In pegmatites and metamorphic rocks. With quartz, topaz, beryl, amazonstone, chrysoberyl.
7.5	White	C—Indistinct F—Uneven Brittle	4.4 4.8	Often in the more acid igneous rocks—granites, syenites; alluvial deposits, with gold, spinel, corundum, garnet. *Hyacinth*, clear and transparent.
7.5 8.	White	C—Basal, indistinct F—Conchoidal, uneven Brittle	2.6 2.8	Crystals usually simple, prism and base. In granitic rocks, mica schists, clay slates. With quartz, feldspar, mica, chrysoberyl, topaz, cassiterite, garnet.
8.	White	C—Basal, perfect, usually conspicuous F—Conchoidal, uneven Brittle	3.4 3.6	Crystals usually developed on one end only. Massive varieties distinguished from quartz by greater hardness, higher specific gravity, and basal cleavage. Color may fade on exposure. In veins and cavities in granitic rocks; alluvial deposits. With cassiterite, tourmaline, fluorite, beryl, scheelite, wolframite.
8.	White	C—Octahedral, indistinct F—Conchoidal Brittle	3.5 4.1	*Balas spinel*, rose red; *ruby spinel*, deep red; *rubicelle*, yellow to orange red; *almandine*, bluish red. Usually in precious stone placers, with zircon, garnet, magnetite; more rarely as contact mineral in crystalline limestones.
9.	White	C—None. Nearly rectangular basal and rhombohedral partings, conspicuous; often striated F—Conchoidal Brittle to tough	3.9 4.1	When massive often multi-colored—blue, green, gray. *Ruby*, transparent, red; *oriental amethyst*, violet. In limestones, granites, schists, peridotites, alluvial deposits. With magnetite, hematite, nephelite, mica, spinel.

Streak—Blue, green, brown, yellow, or black

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
GLAUCONITE $FeKSi_2O_6.H_2O$?	Monoclinic ? **M**—Sand, earthy, disseminated	Dull Opaque	Dark green Light green
CHLORITE (Prochlorite, clinochlorite) $H_8Mg_5Al_2Si_3O_{18}$?	Monoclinic **C**—Tabular, six-sided, often bent and twisted **M**—Foliated, scaly, granular, earthy	Pearly Vitreous Dull Translucent to opaque	Grass green Brownish green Blackish gre
Annabergite (Nickel bloom) $Ni_3(AsO_4)_2.8H_2O$	Monoclinic **C**—Hair-like, indistinct, rare **M**—Earthy, crusts, stains	Dull Vitreous Opaque to translucent	Apple green Light green
Vivianite $Fe_3(PO_4)_2.8H_2O$	Monoclinic **C**—Prismatic, tabular **M**—Reniform, globular, with radial fibrous structure; earthy	Vitreous Dull Transparent to opaque	Indigo blue Bluish green Blackish green
Covellite CuS	Hexagonal **C**—Tabular, rare **M**—Compact, granular, crusts	Submetallic Resinous Opaque	Indigo blue Blue black
CHRYSOCOLLA $H_2CuSiO_4.H_2O$	Amorphous ? **M**—Compact, reniform, incrustations, seams, stains, earthy	Vitreous Greasy Dull Translucent to opaque	Green Greenish blue Blue
Garnierite $H_2(Ni,Mg)SiO_4$	Amorphous ? **M**—Compact, reniform, earthy	Dull Greasy Opaque	Pale green Apple green Emerald gre

Hardness 1 to 3

ard-ess	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
.. 2.	Light green	F—Earthy	2.2 2.3	Commonly as *green sand*. Resembles earthy chlorite. Disseminated in sandstones, limestones, and marl.
.. 2.5	Pale green	C—Basal, perfect; when foliated, conspicuous F—Scaly, earthy Tough to brittle	2.6 3.	Laminæ are flexible but inelastic, with slightly soapy feel. Common in schists and serpentine. With magnetite, garnet, diopside, magnesite. Often as a scaly or dusty coating on other minerals. Pseudomorphous after garnet.
.. 2.5	Pale green	C—None F—Earthy	3. 3.1	Common alteration product of nickel-arsenic minerals. With niccolite, chloanthite, calcite.
1.5 2.	Indigo blue Greenish blue	C—Clinopinacoidal F—Fibrous, earthy Sectile, thin laminæ flexible	2.6 2.7	Color and streak darken on exposure. In clay, peat, bones, shells. With limonite, pyrrhotite, pyrite.
1.5 2.	Dark gray Black	C—Basal F—Uneven Thin plates are flexible	4.6	Characteristic blue color. With chalcopyrite, bornite, chalcocite.
2. 3.	Pale green Pale blue	F—Conchoidal Brittle	2. 2.2	Usually recognized by enamel-like appearance, conchoidal fracture, and non-fibrous structure. When impure brownish or blackish. With copper minerals—malachite, azurite, chalcopyrite.
2. 3.	Pale green	C—None F—Conchoidal, earthy Brittle	2.3 2.8	Often as rounded, pea-shaped masses with varnish-like surfaces and earthy interior. Frequently adheres to tongue. With olivine, serpentine, chromite, talc.

Streak—Blue, green, brown, yellow, or black

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Chalcanthite (Blue vitriol) $CuSO_4.5H_2O$ Parsons 289	Triclinic **C**—Tabular, small, rare **M**—Crusts, reniform, stalactitic, powdery	Vitreous Dull Translucent	Deep blue Sky blue Greenish blu
Zaratite $NiCO_3.2Ni(OH)_2.4H_2O$	**M**—Fine, crystalline, warty crusts; rarely compact	Vitreous Transparent to translucent	Emerald green
Olivenite $Cu(Cu.OH)AsO_4$	Orthorhombic **C**—Prismatic, acicular **M**—Reniform, fibrous, with velvety surface; earthy	Adamantine Vitreous Transparent to opaque	Light green Olive green Blackish gre

Streak—Blue, green, brown, yellow, or black

Atacamite $Cu(OH)Cl.Cu(OH)_2$	Orthorhombic **C**—Slender prismatic, usually in confused fibrous aggregates **M**—Granular, compact, crusts	Vitreous Adamantine Transparent to nearly opaque	Bright green Emerald gre Blackish gre
Chrysocolla $H_2CuSiO_4.H_2O$	Amorphous ? **M**—Compact, reniform, incrustations, seams, stains, earthy	Vitreous Greasy Dull Translucent to opaque	Green Greenish blu Blue
Brochantite $CuSO_4.3Cu(OH)_2$	Orthorhombic **C**—Prismatic, acicular, vertically striated **M**—Reniform, fibrous, drusy crusts	Vitreous Pearly Transparent to translucent	Emerald gre Blackish green

Hardness 1 to 3

rd-ss	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
.5	Light blue	**C**—Indistinct **F**—Conchoidal Brittle	2.1 2.3	Disagreeable metallic taste. Oxidation product of copper sulphide minerals. With chalcopyrite, bornite, melanterite, pyrite, goslarite.
.	Green	**C**—None Brittle	2.6 2.7	As crusts on, or veinlets in chromite, nickeliferous magnetite, associated with serpentine.
.	Olive green	C—None **F**—Conchoidal, uneven Brittle	4.1 4.6	Divergent, fibrous structure and velvety surface important. With copper minerals. Not as common as malachite.

Hardness over 3

. .5	Apple green	**C**—Brachypinacoidal **F**—Conchoidal Brittle	3.7 3.8	With other copper minerals; also limonite, hematite. Not as common as malachite
. .	Apple green Pale blue	**F**—Conchoidal Brittle	2. 2.2	Usually recognized by enamel-like appearance, conchoidal fracture, and non-fibrous structure. When impure brownish or blackish. With copper minerals—malachite, azurite, chalcopyrite.
.5	Light green	**C**—Brachypinacoidal **F**—Uneven Brittle	3.8 3.9	Not as common as malachite. Secondary copper mineral. With malachite, azurite, cuprite, chalcopyrite, limonite.

Streak—Blue, green, brown, yellow, or black

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
AZURITE $2CuCO_3.Cu(OH)$	Monoclinic **C**—Short prismatic, tabular, often in spherical aggregates **M**—Fibrous; botryoidal, with velvety or radial structure; earthy, crusts	Vitreous Dull Translucent to opaque	Azure blue Dark blue
MALACHITE $CuCO_3.Cu(OH)_2$	Monoclinic **C**—Acicular, often in groups or tufts **M**—Fibrous; stalactitic, botryoidal, with smooth surface and internal banded or radial fibrous structure; velvety crusts, earthy	Silky Adamantine Dull Translucent to opaque	Emerald green Grass green Dark green
PYROMORPHITE $Pb_5Cl(PO_4)_3$	Hexagonal **C**—Prismatic, thick tabular, rounded and barrel-shaped **M**—Globular, reniform, disseminated, crusts	Greasy Adamantine Translucent to opaque	Dark green Emerald gr Yellowish green
Dioptase H_2CuSiO_4	Hexagonal **C**—Prismatic, small, highly modified **M**—Crystalline crusts	Vitreous Transparent to opaque	Emerald green Dark green
Lazurite (Lapis lazuli) $(Na_2,Ca)_2Al_2[Al(NaSO_4,NaS_3,Cl)](SiO_4)_3$	Cubic **C**—Dodecahedrons, rare **M**—Compact, irregular grains	Vitreous Translucent to opaque	Azure blue Violet blue Greenish bl
HORNBLENDE (Amphibole) Silicate of Ca, Mg, Fe, Al, etc.	Monoclinic **C**—Long prismatic, prism angle 124°; often with rhombohedral-like terminations **M**—Bladed, fibrous, granular, compact	Vitreous Silky Translucent to opaque	Blackish green Dark green

Hardness over 3

ard-ess	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
3.5 4.	Blue	C—Domatic F—Conchoidal Brittle	3.7 3.8	Common alteration product of copper minerals. With malachite, cuprite, native copper, chalcocite, chalcopyrite, bornite. Pseudomorphous after cuprite, tetrahedrite. Alters to malachite.
3.5 4.	Light green	C—Basal, pinacoidal F—Conchoidal, splintery Brittle	3.7 4.1	Very common alteration product of copper minerals. With azurite, cuprite, native copper, chalcocite, chalcopyrite, bornite. Pseudomorphous after cuprite, azurite, native copper. Surface may be almost black, due to the oxide, melaconite.
3.5 4.	Yellow Greenish yellow	C—None F—Conchoidal, uneven Brittle	6.5 7.1	Alteration product of lead minerals. With galena, cerussite, mimetite, barite, limonite.
5.	Green	C—Rhombohedral F—Conchoidal, uneven Brittle	3.3	In limestone, with quartz, and other copper minerals.
5. 5.5	Pale blue	C—Dodecahedral, distinct F—Uneven Brittle	2.4	Always blue and contains disseminated pyrite. Occurs as contact mineral in crystalline limestone.
5. 6.	Grayish green Grayish brown Yellowish	C—Prismatic, perfect, often conspicuous —124° Brittle	2.9 3.3	Simple, pseudohexagonal crystals, and cleavage—124°—important. In nearly all types of igneous rocks. With quartz, feldspar, pyroxene, chlorite, calcite.

Streak—Blue, green, brown, yellow, or black

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
AUGITE (Pyroxene) Silicate of Ca, Mg, Fe, Al, etc.	Monoclinic **C**—Short, prismatic, thick columnar; prism angle 87° **M**—Compact, granular, disseminated	Vitreous Submetallic Translucent to opaque	Blackish green Leek green
Turquois $H_5[Al(OH)_2]_6Cu(OH)(PO_4)_4$	Triclinic **M**—Reniform, stalactitic, disseminated, rounded pebbles	Waxy Dull Opaque to translucent	Sky blue Bluish green Apple green
GLAUCOPHANE (Amphibole) Silicate of Ca, Mg, Fe, Al, Na, etc.	Monoclinic **C**—Prismatic, indistinct **M**—Columnar, fibrous granular	Vitreous Pearly Translucent	Azure blue Lavender b Grayish blue
CHLORITOID $H_2FeAl_2SiO_7$	Monoclinic **C**—Tabular, six-sided **M**—Foliated, scaly, platy; fan- and sheaf-like aggregates	Vitreous Pearly Translucent to opaque	Dark green Grayish gree Blackish green

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
* **Cerargyrite** (Horn silver) AgCl	Cubic **C**—Rare **M**—Wax-like crusts and coatings; stalactitic, dendritic	Adamantine Waxy Greasy Transparent to translucent	Grayish green Greenish Grayish blu
GLAUCONITE $FeKSi_2O_6.H_2O$?	Monoclinic ? **M**—Sand, earthy, disseminated	Dull Opaque	Dark green Light green
Pyrophyllite $H_2Al_2Si_4O_{12}$	Orthorhombic **C**—Indistinct **M**—Radiated fibrous, lamellar aggregates; granular, compact	Greasy Pearly Dull Translucent to opaque	Apple green Grayish gre Brownish green

*Uncommon color.

Hardness over 3

ard-ess	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
5. 6.	Pale green Grayish green	C—Prismatic, perfect, conspicuous—87° Brittle	3.2 3.6	Crystals, usually eight-sided, more rarely four sided; pseudotetragonal with prism angles of 87° and 93°. Cleavage less distinct than on hornblende. Common in basic eruptive rocks and crystalline limestones.
6.	Pale green	F—Conchoidal Brittle	2.6 2.8	Secondary mineral, common in thin veins, crusts, or coatings. With limonite, quartz, feldspar, kaolin.
6. 6.5	Grayish blue	C—Prismatic F—Uneven, conchoidal Brittle	3. 3.1	In metamorphic rocks. With mica, amphibole, pyroxene, garnet, epidote, zoisite.
6. 7.	Pale green	C—Basal, perfect, conspicuous F—Scaly Brittle	3.4 3.6	Sometimes softer due to alteration. Recognized by micaceous structure, perfect cleavage, and hardness. In clay slates, mica schists. With corundum, garnet, chlorite, hornblende.

Hardness 1 to 3

.. ..5	White, shiny Gray, shiny	C—None F—Conchoidal Highly sectile	5.5 5.6	Cuts like wax, yielding shiny surfaces; on exposure turns violet, brown, or black. With silver minerals—argentite, native silver; also limonite, calcite, barite.
.. 2.	Greenish white	F—Earthy	2.2 2.3	Commonly as *green sand*. Resembles earthy chlorite. Disseminated in sandstones, limestones, and marls.
. .	White	C—Longitudinal F—Fibrous, uneven Laminæ flexible	2.8 2.9	Soft and greasy like talc, but usually in radiating fibers. In schistose rocks. With cyanite, lazulite, topaz, graphite.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Asbestos, variety *Chrysotile* $H_4Mg_3Si_2O_9$	Orthorhombic ? **M**—Fibrous, coarse or fine; felted	Silky Silky metallic Opaque	Light green Olive green
variety *Amphibole* Silicate of Ca, Mg, Fe, Al, etc.	Monoclinic ? **M**—Fibrous, coarse or fine; felted	Silky Opaque	Greenish
*KAOLINITE (Kaolin) $H_4Al_2Si_2O_9$	Monoclinic **C**—Scaly, hexagonal or orthorhombic outline, rare **M**—Compact, friable, clay-like	Dull Pearly Opaque to translucent	Bluish Greenish
Vivianite $Fe_3(PO_4)_2.8H_2O$	Monoclinic **C**—Prismatic, tabular **M**—Reniform, globular, with radial fibrous structure; earthy	Vitreous Dull Translucent to opaque	Indigo blue Bluish green Blackish gre
TALC, varieties *Foliated* *Soapstone* or *steatite* $H_2Mg_3Si_4O_{12}$	Monoclinic **C**—Thin tabular, indistinct **M**—Foliated, globular, granular, compact, fibrous	Pearly Greasy Opaque to transparent	Pale green Apple green Dark green
CHLORITE (Pyrochlorite, clinochlorite) $H_8Mg_5Al_2Si_3O_{18}$?	Monoclinic **C**—Tabular, six-sided, often bent, twisted **M**—Foliated, scaly, granular, earthy	Pearly Vitreous Dull Translucent to opaque	Grass green Brownish green Blackish green
Annabergite (Nickel bloom) $Ni_3(AsO_4)_2.8H_2O$	Monoclinic **C**—Hair-like, indistinct, rare **M**—Earthy, crusts, stains	Dull Vitreous Opaque to translucent	Apple green Light green

* Uncommon color.

Hardness 1 to 3

ard-ess	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
1. 2.5	White	**F**—Fibrous Flexible	1. 2.5	Delicate, fine, parallel, flexible fibers perpendicular to walls, easily separable, called *short fibered asbestos;* compare below. In veins or seams in compact serpentine.
1. 2.5	White	**F**—Fibrous Flexible	1. 2.5	*Long fibered asbestos,* parallel, flexible fibers. Fibers parallel to walls. Compare above.
1. 2.5	White Bluish white	**C**—Basal (scales) **F**—Earthy Brittle	2.2 2.6	Clay odor when breathed upon. Usually adheres to tongue and becomes plastic when moistened. Greasy feel. With quartz, feldspar, corundum, diaspore, topaz.
1. 2.5	Bluish white Greenish white White	**C**—Clinopinacoidal **F**—Fibrous, earthy Sectile, thin laminæ flexible	2.6 2.7	Color and streak darken on exposure. In clay, peat, bones, shells. With limonite, pyrrhotite, pyrite.
1. 2.5	White	**C**—Basal, conspicuous on foliated masses **F**—Uneven Sectile, laminæ flexible	2.6 2.8	Greasy or soapy feel. *Foliated,* easily separable, inelastic folia or plates, H = 1; *Soapstone* or *steatite,* coarse to fine granular, more or less impure, H = 1.5 – 2.5. With serpentine, dolomite, magnesite, actinolite.
1. 2.5	White Greenish white	**C**—Basal, conspicuous, when foliated **F**—Scaly, earthy Tough to brittle	2.6 3.	Laminæ flexible but inelastic, with slightly soapy feel. Common in schists and serpentine. With magnetite, magnesite, garnet, diopside. Often as scaly or dusty coating on other minerals. Pseudomorphous after garnet.
1. 2.5	White Greenish white	**C**—None **F**—Earthy	3. 3.1	Common alteration product of nickel-arsenic minerals. With niccolite, chloanthite, calcite.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Melanterite (Copperas) $FeSO_4.7H_2O$	Monoclinic **C**—Rare **M**—Capillary, fibrous, stalactitic, concretionary, powder	Vitreous Dull Transparent to translucent	Green Yellowish green
***Sylvite** KCl	Cubic **C**—Cubes, alone or with octahedron **M**—Granular, compact	Vitreous Transparent to translucent	Bluish
***HALITE** (Rock salt) NaCl	Cubic **C**—Cubes, often skeletal or hopper-shaped **M**—Compact, cleavable, granular, fibrous, stalactitic, crusts	Vitreous Transparent to opaque	Bluish Blue Greenish
Brucite $Mg(OH)_2$	Hexagonal **C**—Broad tabular **M**—Foliated, fibrous, scaly	Pearly Vitreous Transparent to translucent	Greenish white Green Bluish
CHRYSOCOLLA $H_2CuSiO_4.H_2O$	Amorphous ? **M**—Compact, reniform, incrustations, seams, stains, earthy	Vitreous Greasy Dull Translucent to opaque	Green Greenish blue Blue
Garnierite $H_2(Ni,Mg)SiO_4$	Amorphous ? **M**—Compact, reniform, earthy	Dull Greasy Opaque	Pale green Apple green Emerald green
Actinolite (Amphibole) $H_2Ca_2Fe_5(SiO_3)_8$	Monoclinic **C**—Fine, acicular **M**—Interwoven fibrous aggregates; radiating masses	Vitreous Silky Translucent to opaque	Grass green Grayish green

* Uncommon color.

Hardness 1 to 3

ard-ess	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
2.	White	C—Basal, not conspicuous F—Conchoidal, earthy Brittle	1.8 1.9	On exposure loses water and crumbles to powder. Sweet, astringent taste, somewhat metallic. Oxidation product of iron sulphide minerals—marcasite, pyrite, chalcopyrite, pyrrhotite.
2. 2.5	White	C—Cubic F—Conchoidal Brittle	1.9 2.	Color due to impurities. Salty, bitter taste. May absorb moisture and become damp. Usually in salt deposits. With halite, kainite, carnallite.
2. 2.5	White	C—Cubic, perfect, conspicuous F—Conchoidal Brittle	2.1 2.3	Characteristic cubical cleavage and saline taste. May absorb moisture and become damp. With shale, gypsum, anhydrite, polyhalite.
2. 2.5	White	C—Basal, perfect, conspicuous Thin plates or scales, flexible	2.3 2.4	Distinguished from mica by non-elasticity and distinct pearly luster. Foliated talc is softer with greasy feel. With serpentine, limestone.
2. 3.	White Greenish white Bluish white	F—Conchoidal Brittle	2. 2.2	Usually recognized by enamel-like appearance, conchoidal fracture, and non-fibrous structure. When impure brownish or blackish. With copper minerals—malachite, azurite, chalcopyrite; also limonite.
2. 3.	White Greenish white	C—None F—Conchoidal, earthy Brittle	2.3 2.8	Often as rounded, pea-shaped masses, with varnish-like surfaces and earthy interior. May adhere to tongue. With olivine, serpentine, chromite, talc.
2. 3.	White Greenish white	C—Fibrous Brittle	2.9 3.2	Masses of delicate, interwoven fibers—*actinolite schist.* A pale grayish green, highly ferruginous variety (*grünerite*, $H_2Fe_7(SiO_3)_8$) associated with quartz and magnetite is termed *magnetite-grünerite schist.*

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Chalcanthite (Blue vitriol) $CuSO_4.5H_2O$	Triclinic **C**—Tabular, small, rare **M**—Crusts, reniform, stalactitic, fibrous, powdery	Vitreous Dull Translucent	Deep blue Sky blue Greenish bl
***Leadhillite** $PbSO_4.2PbCO_3.Pb(OH)_2$	Monoclinic **C**—Tabular, pseudohexagonal; twins, trillings **M**—Compact, lamellar	Pearly Adamantine Transparent to translucent	Greenish
***Gibbsite** (Hydrargillite) $Al(OH)_3$	Monoclinic **C**—Pseudohexagonal, tabular, rare **M**—Stalactitic, mammillary, surface smooth, internal structure fibrous; scaly aggregates	Vitreous Pearly Translucent	Greenish Bluish white
MICAS ***PHLOGOPITE** $(K,H)_3Mg_3Al(SiO_4)_3$	Monoclinic **C**—Prismatic, tabular, hexagonal or orthorhombic outline, often large or coarse **M**—Plates, disseminated scales	Pearly Submetallic Transparent to translucent	Green
MICAS **BIOTITE** $(K,H)_2(Mg,Fe)_2(Al,Fe)_2(SiO_4)_3$	Monoclinic **C**—Tabular, hexagonal or rhombohedral habit **M**—Plates, disseminated scales	Pearly Submetallic Transparent to opaque	Brownish green Blackish green
BARITE (Heavy spar) $BaSO_4$	Orthorhombic **C**—Tabular, prismatic, crested divergent groups, common **M**—Compact, lamellar fibrous, cleavable, reniform	Vitreous Pearly Transparent to opaque	Bluish Greenish

* Uncommon color.

Hardness 1 to 3

ard-ess	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
2.5	White Bluish white	C—Indistinct F—Conchoidal, earthy Brittle	2.1 2.3	Disagreeable metallic taste. Oxidation product of copper sulphide minerals. With chalcopyrite, bornite, melanterite, pyrite, goslarite.
2.5	White	C—Basal, perfect F—Conchoidal Rather sectile	6.2 6.4	Soft and very heavy. Twins and trillings resemble those of aragonite. Usually with lead minerals, but sparingly. Pseudomorphous after calcite, galena.
2.5 3.	White	C—Basal, not conspicuous Tough	2.3 2.4	Slight clay odor when breathed upon. With bauxite, natrolite, limonite, corundum.
2.5 3.	White Gray	C—Basal, perfect, conspicuous Tough, laminæ very elastic	2.8 3.	Especially characteristic of crystalline limestones, dolomites, schists. With pyroxenes, amphiboles, serpentine, apatite.
2.5 3.	White Grayish	C—Basal, perfect, conspicuous Tough, laminæ of fresh biotite very elastic	2.7 3.2	Easily recognized by structure, highly perfect cleavage, and elasticity. Important constituent of many igneous and metamorphic rocks—granite, syenite, gneiss.
2.5 3.	White	C—Basal, prismatic, conspicuous F—Uneven Brittle	4.3 4.7	Characterized by rather high specific gravity and cleavages. In metalliferous veins; pockets, lenticular masses in limestone. With galena, sphalerite, chlorite, chalcopyrite; manganese and iron minerals.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Allophane $Al_2SiO_5.5H_2O$	Amorphous **M**—Reniform, mammillary, stalactitic, incrusting	Vitreous Greasy Translucent	Sky blue Bluish green Deep green
CALCITE $CaCO_3$	Hexagonal **M**—Cleavable, granular, fibrous, compact	Vitreous Dull Transparent to nearly opaque	Sky blue Deep blue Greenish
***Wulfenite** $PbMoO_4$	Tetragonal **C**—Square, thin tabular; more rarely pyramidal **M**—Coarse, fine grained	Adamantine Greasy Transparent to translucent	Light green Olive green

Streak—Uncolored, white, or light gray

***Gibbsite** (Hydrargillite) $Al(OH)_3$	Monoclinic **C**—Pseudohexagonal, tabular, rare **M**—Stalactitic, mammillary, surface smooth, internal structure fibrous; scaly aggregates	Vitreous Pearly Translucent	Greenish Bluish white
ANHYDRITE $CaSO_4$	Orthorhombic **C**—Thick tabular, prismatic, rare **M**—Granular, compact, fibrous, lamellar, cleavable, reniform	Vitreous Pearly Translucent to opaque	Bluish Grayish blue Blue
CELESTITE $SrSO_4$	Orthorhombic **C**—Tabular, prismatic, common; pyramidal **M**—Compact, cleavable, fibrous, granular, reniform	Vitreous Pearly Transparent to translucent	Sky blue Blue Greenish

* Uncommon color.

Hardness 1 to 3

Hardness	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
3.	White	F—Conchoidal, earthy Brittle	1.9	Structure resembles opal. In fissures and cavities with copper and iron minerals.
3.	White	C—Rhombohedral perfect, conspicuous F—Conchoidal Brittle	2.7	Rhombohedral cleavage generally characteristic. Cleavages often show striations.
3.	White	C—Pyramidal, indistinct F—Conchoidal, uneven Brittle	6.3 7.	Square plates, sometimes with forms of the third order. With lead minerals—galena, pyromorphite, vanadinite,

Hardness 3 to 6

3. 3.5	White	C—Basal, not conspicuous Tough	2.3 2.4	Slight clay odor when breathed upon. With bauxite, natrolite, limonite, corundum.
3. 3.5	White	C—Pinacoidal, perfect, 3 directions at 90° F—Conchoidal Brittle	2.8 3.	Pseudocubical cleavage, sometimes noted. Granular varieties resemble marble. Not as heavy as celestite or barite. In limestone, shale. With halite, gypsum.
3. 3.5	White	C—Basal, prismatic, conspicuous F—Uneven Brittle	3.9 4.	Heavier than calcite, anhydrite; lighter than barite. In limestones, dolomites, shales. With sulphur, gypsum, aragonite, halite, galena, sphalerite.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
BARITE (Heavy spar) $BaSO_4$	Orthorhombic **C**—Tabular, prismatic, crested divergent groups, common **M**—Compact, lamellar, fibrous, cleavable, reniform	Vitreous Pearly Transparent to translucent	Bluish Greenish
***ANGLESITE** $PbSO_4$	Orthorhombic **C**—Prismatic, tabular, pyramidal **M**—Compact, granular, nodular	Adamantine Greasy Transparent to translucent	Green Blue
CHRYSOCOLLA $H_2CuSiO_4.H_2O$	Amorphous ? **M**—Compact, reniform, incrustations, seams, stains, earthy	Vitreous Greasy Dull Translucent to opaque	Blue Bluish green Green
SERPENTINE $H_4Mg_3Si_2O_9$	Monoclinic **C**—Unknown **M**—Compact, columnar, fibrous, lamellar, granular	Greasy Waxy Translucent to opaque	Light green Olive green Yellowish green Blackish gree
Wavellite $(Al.OH)_3(PO_4)_2.5H_2O$	Orthorhombic **C**—Capillary, small **M**—Crusts, globular or hemispherical, with radial fibrous structure	Vitreous Translucent	Green Bluish green Blue

* Uncommon color.

Hardness 3 to 6

rd-ess	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
. .5	White	C—Basal, prismatic, conspicuous F—Uneven Brittle	4.3 4.7	Characterized by rather high specific gravity and cleavages. In metalliferous veins; pockets, lenticular masses in limestone. With galena, sphalerite, chalcopyrite; manganese and iron minerals.
. .5	White	C—Basal, prismatic F—Conchoidal Brittle	6.1 6.4	Luster and very high specific gravity important. Oxidation product of lead minerals. Usually in cracks and cavities. With galena, cerussite.
. . .	White Greenish white Bluish white	F—Conchoidal Brittle	2. 2.2	Usually recognized by enamel-like appearance, conchoidal fracture, and non-fibrous structure. When impure brownish or blackish. With copper minerals—malachite, azurite, chalcopyrite; also limonite.
. .	White	F—Conchoidal, splintery Brittle	2.5 2.8	Smooth and greasy feel. Often spotted, clouded, and multicolored. Sometimes crossed by seams of asbestos (chrysotile). *Verd-antique*, massive, green and mixed with calcite, dolomite, or magnesite; takes an excellent polish. With magnesite, chromite, garnierite, pyrope, platinum.
.5 .	White	C—Pinacoidal, domatic F—Conchoidal, uneven, fibrous Brittle	2.3 2.4	Secondary mineral occurring on surfaces of rocks or minerals, as crystalline crusts with pronounced radial, fibrous structure.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
*ARAGONITE $CaCO_3$	Orthorhombic **C**—Chisel- or spear-shaped; pseudohexagonal prisms; radial columnar, acicular aggregates **M**—Stalactitic, reniform, crusts, oolitic	Vitreous Transparent to translucent	Greenish Bluish Violet
Scorodite $FeAsO_4.2H_2O$	Orthorhombic **C**—Prismatic, pyramidal drusy **M**—Botryoidal, fibrous, earthy, crusts	Vitreous Greasy Translucent	Pale green Bluish green Blackish green Blue
*STRONTIANITE SrCO	Orthorhombic **C**—Spear-shaped, columnar, acicular, often in divergent groups **M**—Granular, compact, botryoidal, fibrous	Vitreous Transparent to translucent	Light green Apple green
PYROMORPHITE $Pb_5Cl(PO_4)_3$	Hexagonal **C**—Prismatic, thick tabular, rounded and barrel-shaped; acicular **M**—Globular, reniform, disseminated, crusts	Greasy Adamantine Translucent to opaque	Dark green Emerald gre Yellowish green
*RHODOCHROSITE $MnCO_3$	Hexagonal **C**—Rhombohedral, rare **M**—Cleavable, granular, compact, botryoidal, crusts	Vitreous Translucent	Greenish
FLUORITE (Fluor spar) CaF	Cubic **C**—Cubes, alone or modified, well developed, common; penetration twins **M**—Cleavable, granular, fibrous	Vitreous Transparent to nearly opaque	Greenish Bluish green Blue violet

* Uncommon color.

Hardness 3 to 6

rd-ss	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
5	White	C—Pinacoidal, prismatic F—Conchoidal Brittle	2.9 3.	Twins common, often pseudohexagonal—prism and striated base. In cracks and cavities with ore deposits; deposition from hot springs; in shells. With gypsum, celestite, sulphur, siderite, zeolites.
5	White Grayish Greenish white	C—Imperfect F—Uneven, conchoidal Brittle	3.1 3.3	With arsenopyrite, enargite, limonite, pyrite
5	White	C—Prismatic, indistinct F—Uneven Brittle	3.6 3.8	Similar to aragonite. Divergent columnar structure, and higher specific gravity characteristic. In ore deposits; independent beds. With galena, barite, calcite.
5	White Yellowish white	C—None F—Conchoidal, uneven Brittle	6.5 7.1	Common alteration product of lead minerals. With galena, cerussite, mimetite, barite, limonite.
5 5	White	C—Rhombohedral, perfect, conspicuous F—Uneven Brittle	3.3 3.6	May turn brown or black on exposure, due to MnO_2. With ore deposits. With galena, sphalerite, pyrite, alabandite, psilomelane, silver minerals.
	White	C—Octahedral, perfect, conspicuous Brittle	3. 3.2	May show fluorescence. Easily recognized by crystal form, octahedral cleavage, and hardness. Common gangue of metallic ores—galena, sphalerite, cassiterite; also with calcite, barite.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
CYANITE (Disthene, kyanite) Al_2SiO_5	Triclinic **C**—Long, bladed, without good terminations; sometimes curved and radially grouped **M**—Coarsely bladed, columnar, fibrous	Vitreous Translucent to transparent	Sky blue Greenish bl Bluish whit
*Scheelite $CaWO_4$	Tetragonal **C**—Pyramidal, small, more rarely tabular **M**—Drusy crusts, reniform, granular, disseminated	Adamantine Greasy Transparent to translucent	Greenish
APATITE $Ca_5F(PO_4)$	Hexagonal **C**—Prismatic, thick, tabular, common, sometimes large with rounded edges **M**—Compact, fibrous, nodular, reniform	Greasy Vitreous Translucent to opaque	Grass green Brownish green Bluish gree Blue violet
***HEMIMORPHITE** (Calamine) $H_2Zn_2SiO_5$	Orthorhombic **C**—Thin tabular, pyramidal, hemimorphic, highly modified **M**—Compact, globular, stalactitic, fibrous, granular	Vitreous Transparent to opaque	Pale blue Bluish gree Pale green
SMITHSONITE $ZnCO_3$	Hexagonal **C**—Small, usually as druses or crusts **M**—Botryoidal, stalactitic, granular, fibrous, compact	Vitreous Dull Translucent	Green Grayish gre Greenish bl Blue
Lazurite (Lapis lazuli) $(Na_2,Ca)_2Al_2[Al(NaSO_4,NaS_3,Cl)](SiO_4)_3$	Cubic **C**—Dodecahedrons, rare **M**—Compact, irregular grains	Vitreous Translucent to opaque	Azure blue Violet blue Greenish bl

* Uncommon color.

Hardness 3 to 6

ard-ess	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
4. 5.	White	C—Pinacoidal, perfect, conspicuous Brittle	3.5 3.7	Color irregularly distributed, frequently with lighter longitudinal margins. Hardness varies with direction, 4–5 parallel to long direction, 6–7 at right angles thereto. In gneiss, mica schist. With staurolite, garnet, corundum.
4.5	White	C—Pyramidal F—Conchoidal, uneven Brittle	5.9 6.2	Small, well developed octahedral-like crystals, usually on quartz; when massive high specific gravity important. With cassiterite, wolframite, fluorite, apatite, molybdenite, topaz.
4.5 5.	White	C—Basal, imperfect F—Conchoidal, uneven Brittle	3.1 3.2	Crystals may be vertically striated and have fused appearance. Color often unevenly distributed —brownish spots. In crystalline limestones; metalliferous ore deposits; igneous rocks. With quartz, cassiterite, fluorite, wolframite.
4.5 5.	White	C—Prismatic F—Uneven, conchoidal Brittle	3.3 3.5	Crystals often in sheaf-like groups or druses in cavities. In limestone. With sphalerite, galena, and especially smithsonite.
5.	White Gray	C—Rhombohedral, not often observed F—Uneven, splintery Brittle	4.1 4.5	With zinc minerals, especially sphalerite, hemimorphite.
5. 5.5	White Bluish white	C—Dodecahedral, imperfect F—Uneven Brittle	2.4	Always blue and contains disseminated pyrite. Occurs as contact mineral in crystalline limestone.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Datolite $Ca(B.OH)SiO_4$	Monoclinic **C**—Prismatic, pyramidal, tabular, highly modified **M**—Compact, fibrous, granular, botryoidal	Vitreous Greasy Dull Transparent to opaque	Pale green Olive green
Lazulite $Mg(Al.OH)_2(PO_4)_2$	Monoclinic **C**—Acute pyramidal, tabular **M**—Compact, granular	Vitreous Translucent to opaque	Azure blue Sky blue
TITANITE (Sphene) $CaTiSiO_5$	Monoclinic **C**—Wedge- or envelope-shaped when disseminated; tabular or prismatic when attached **M**—Compact, lamellar	Vitreous Greasy Transparent to translucent	Green Yellowish green
Sodalite $Na_4Al_2(AlCl)(SiO_4)_3$	Cubic **C**—Dodecahedrons **M**—Compact, disseminated grains, nodular	Vitreous Greasy Transparent to translucent	Lavender bl Sky blue Dark blue Greenish
***Cancrinite** $H_6(Na_2,Ca)_4(NaCO_3)_2Al_6Si_9O_{36}$	Hexagonal **C**—Prismatic, rare **M**—Compact, lamellar, columnar, disseminated	Vitreous Pearly Greasy Transparent to translucent	Green Grayish blue Blue
NEPHELITE (Nepheline, elæolite) $(Na,K)_8Al_8Si_9O_{34}$	Hexagonal **C**—Short prismatic, tabular **M**—Compact, disseminated grains	Greasy Vitreous Transparent to opaque	Grayish gree Brownish green Grayish blue
SCAPOLITE (Wernerite) $\begin{cases} nNa_4Al_3Si_9O_{24}Cl \\ mCa_4Al_6Si_6O_{25} \end{cases}$	Tetragonal **C**—Thick prismatic, coarse, often large **M**—Compact, granular, fibrous, columnar	Vitreous Greasy Translucent to opaque	Grayish gree Bluish

*Uncommon color.

Hardness 3 to 6

ard-ness	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
5. 5.5	White	C—None F—Conchoidal, uneven Brittle	2.9 3.	Crystals glassy and usually well developed. Compact masses often with brownish, yellowish, reddish streaks and spots. In cracks and cavities in basic igneous rocks. With calcite, prehnite, native copper, magnetite, zeolites.
5. 5.5	White	C—Indistinct F—Uneven Brittle	3. 3.1	Pyramidal crystals are pseudotetragonal and well developed. Disseminated in quartz, clay or slate. With corundum, cyanite, rutile.
5. 5.5	White Grayish	C—Prismatic, conspicuous parting often noted F—Conchoidal Brittle	3.4 3.6	With feldspars, pyroxenes, amphiboles, chlorite, scapolite, zircon.
5. 6.	White	C—Dodecahedral F—Conchoidal, uneven Brittle	2.2 2.4	Commonly massive and blue in color. Recognized by associates—nephelite, cancrinite, leucite, feldspar, zircon; not with quartz.
5. 6.	White	C—Prismatic, perfect F—Uneven Brittle	2.4 2.5	Associates important—nephelite, sodalite, biotite, feldspar, titanite.
5. 6.	White	C—Indistinct F—Conchoidal, uneven Brittle	2.6	Greasy luster and associates important. With feldspar, cancrinite, biotite, sodalite, zircon, leucite; not with quartz.
5. 6.	White	C—Prismatic F—Conchoidal Brittle	2.6 2.8	Crystals may appear as though fused. Typical contact mineral. In metamorphic rocks, especially granular limestones. With pyroxenes, garnet, mica, amphiboles, wollastonite.

Streak—Uncolored, white, or light gray

	Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
AMPHIBOLES	**Actinolite** $H_2Ca_2Fe_5(SiO_3)_8$	Monoclinic **C**—Bladed, without terminations **M**—Columnar, fibrous, often divergent; granular, compact	Vitreous Silky Transparent to opaque	Light green Grayish gre Dark green
	HORNBLENDE Silicate of Ca, Mg, Fe, Al, etc.	Monoclinic **C**—Long prismatic, prism angle 124°; often with rhombohedral-like terminations **M**—Bladed, fibrous, granular, compact	Vitreous Silky Translucent to opaque	Blackish green Dark green
PYROXENES	**ENSTATITE** $Mg_2(SiO_3)_2$	Orthorhombic **C**—Prismatic, rare **M**—Fibrous, lamellar, columnar, compact	Vitreous Pearly Translucent to opaque	Grayish gre Brownish green Olive green
	Bronzite $(Mg,Fe)_2(SiO_3)_2$	Orthorhombic **C**—Prismatic, rare **M**—Fibrous, lamellar, compact	Bronzy Silky Translucent to opaque	Grayish gre Brownish green Olive green
	Hypersthene $(Fe,Mg)_2(SiO_3)_2$	Orthorhombic **C**—Prismatic, tabular, rare **M**—Granular, foliated, cleavable aggregates	Pearly Metalloidal Translucent to opaque	Brownish green Blackish gr
	DIOPSIDE $CaMg(SiO_3)_2$	Monoclinic **C**—Prismatic, thick columnar, prism angle 87° **M**—Compact, granular, columnar, lamellar	Vitreous Dull Transparent to opaque	Pale green Bright gree Dark green
	AUGITE Silicate of Ca, Mg, Fe, Al, etc.	Monoclinic **C**—Short prismatic, thick columnar, prism angle 87° **M**—Compact, granular, disseminated	Vitreous Submetallic Translucent to opaque	Blackish gr Leek green

Hardness 3 to 6

Hardness	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
5. 6.	White Greenish white	C—Prismatic, often conspicuous, 124° Brittle	2.9 3.2	Often as radiating masses. In talc and chlorite schists. With serpentine, epidote, calcite. *Nephrite* and *jade* are compact massive varieties.
5. 6.	Gray Greenish gray Brownish gray	C—Prismatic, often conspicuous, 124° Brittle	2.9 3.3	Simple, pseudohexagonal crystals, and cleavage—124°—important. Common in many types of rocks. With quartz, feldspar, pyroxene, chlorite, calcite.
5. 6.	White Greenish white Grayish	C—Prismatic, pinacoidal F—Uneven Brittle	3.1 3.3	Often softer due to alteration to serpentine. Commonly in basic igneous rocks. With olivine, serpentine, chondrodite, talc.
5. 6.	White Grayish	C—Prismatic, pinacoidal, often conspicuous F—Uneven Brittle	3.2 3.5	Cleavage surfaces often fibrous or lamellar, irregular or wavy, with distinct bronzy luster. Darker than enstatite. In basic igneous rocks.
5. 6.	White Gray Brownish gray	C—Brachypinacoidal, conspicuous F—Uneven Brittle	3.3 3.5	Copper red iridescence often noted, due to small, tabular inclusions. In basic igneous rocks. With feldspar (labradorite), olivine, hornblende, pyrrhotite, magnetite.
5. 6.	White Gray	C—Prismatic; conspicuous basal parting F—Uneven Brittle	3.2 3.3	Crystals prismatic and pseudotetragonal with distinct basal parting. May have colorless and dark green zones. In crystalline limestones and schists. With vesuvianite, garnet, scapolite, spinel, apatite.
5. 6.	White Gray Greenish gray	C—Prismatic, perfect, conspicuous—87° Brittle	3.2 3.6	Crystals usually eight-sided, more rarely four-sided; pseudotetragonal with prism angles of 87° and 93°. Cleavage less distinct than on hornblende. In basic igneous rocks and crystalline limestones.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
CHLORASTROLITE $H_2Ca_2Al_2(SiO_4)_3$?	**C**—Unknown **M**—Rounded grains, pebbles	Vitreous Silky Translucent	Green Bluish green Dark green
Willemite Zn_2SiO_4	Hexagonal **C**—Prismatic **M**—Compact, granular, disseminated grains	Vitreous Greasy Translucent to opaque	Apple green Yellowish green
OPAL $SiO_2.nH_2O$	Amorphous **M**—Reniform, botryoidal, compact	Vitreous Greasy Translucent to opaque	Green Bluish green Blue
Turquois $H_5[Al(OH)_2]_6Cu(OH)(PO_4)_4$	Triclinic **M**—Reniform, stalactitic, disseminated grains, rounded pebbles	Waxy Dull Opaque to translucent	Sky blue Bluish green Apple green
***Amblygonite** $Li(AlF)PO_4$	Triclinic **C**—Rare **M**—Cleavable, columnar, compact	Pearly Vitreous Translucent	Greenish Bluish

Streak—Uncolored, white, or light gray

	Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
FELDSPARS	**MICROCLINE,** variety *Amazonstone* $KAlSi_3O_8$	Triclinic **C**—Prismatic, thick tabular, twins **M**—Cleavable, granular, compact, disseminated	Vitreous Pearly Translucent to transparent	Bright green Bluish green
	LABRADORITE Silicate of Ca,Na,Al	Triclinic **C**—Thin tabular, often with rhombic cross-section **M**—Compact, cleavable, granular	Vitreous Pearly Translucent to nearly opaque	Grayish green Greenish

* Uncommon color.

Hardness 3 to 6

Hardness	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
5. 6.	White	F—Uneven, fibrous Brittle	3.2	Rounded grains in basic, amygdaloidal rocks, also as pebbles. Color unevenly distributed. May show radial, fibrous structure and chatoyancy.
5. 6.	White	C—Basal F—Uneven Brittle	3.9 4.3	Characterized by associates—franklinite (black), zincite (red), rhodonite (flesh red), calcite.
5.5 6.	White	F—Conchoidal, conspicuous	2.1 2.3	Structure and fracture characteristic. *Precious opal*, play of colors. In veins, cavities, and masses of irregular outline.
6.	White Greenish white	F—Conchoidal Brittle	2.6 2.8	Secondary mineral, commonly in thin veins, crusts, or coatings. With quartz, feldspar, kaolin, limonite.
6.	White	C—Basal, perfect, conspicuous; macropinacoidal, domatic F—Uneven, conchoidal Brittle	3. 3.1	Usually in cleavable masses with perfect cleavage in one direction. With lepidolite, rubellite, topaz, wavellite, petalite.

Hardness over 6

6. 6.5	White	C—Basal, brachypinacoidal, conspicuous, 90° 30′ F—Uneven Brittle	2.5 2.6	Slightly inclined cleavages; may show twinning striations on basal pinacoid. With quartz, other feldspars, mica, hornblende, topaz, phenacite.
6. 6.5	White	C—Basal, brachypinacoidal, conspicuous, 86° F—Uneven, conchoidal Brittle	2.7	Often with play of color—yellow, green, blue, red. Inclined cleavages are striated. In basic igneous rocks. With pyroxenes, amphiboles.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
GLAUCOPHANE (Amphibole) Silicate of Mg, Fe, Ca, Al, Na	Monoclinic C—Prismatic, indistinct M—Columnar, fibrous, granular	Vitreous Pearly Translucent	Azure blue Lavender bl Grayish blu
Zoisite $Ca_2Al_2(Al.OH)(SiO_4)_3$	Orthorhombic C—Prismatic, deeply striated, bent, without good terminations M—Columnar, broad bladed, fibrous	Vitreous Pearly Translucent to opaque	Grayish gre Apple green
Prehnite $H_2Ca_2Al_2(SiO_4)_3$	Orthorhombic C—Tabular, prismatic; curved, sheaf-like groups M—Botryoidal, stalactitic, radial fibrous	Vitreous Waxy Transparent to translucent	Light green Apple green Yellowish green
Spodumene (Pyroxene), variety *Hiddenite* $LiAl(SiO_3)_2$	Monoclinic C—Long prismatic, faces often etched	Vitreous Transparent to translucent	Yellowish green Emerald gr
***Sillimanite** (Fibrolite) Al_2SiO_5	Orthorhombic C—Long, thin needle-like M—Fibrous, columnar, radiating	Vitreous Silky Transparent to translucent	Grayish gre Pale olive green
Axinite $M_7''M_4'''B_2(SiO_4)_8$ $M'' = Ca, Fe, Mn, Mg$ $M''' = Al, Fe$	Triclinic C—Broad tabular, with sharp edges M—Lamellar, granular	Vitreous Transparent to translucent	Green Yellowish green Plum blue

* Uncommon color.

Hardness over 6

Hardness	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
6. 6.5	Bluish gray	C—Prismatic F—Uneven, conchoidal Brittle	3. 3.1	In metamorphic rocks. With mica, amphiboles, pyroxenes, garnet, epidote, zoisite.
6. 6.5	White	C—Pinacoidal, perfect, conspicuous F—Uneven Brittle	3.3 3.4	Deeply furrowed and transversely broken, columnar masses. In crystalline schists. With hornblende, cyanite, epidote, garnet, vesuvianite, feldspar.
6. 7.	White	C—Basal, indistinct F—Uneven Brittle	2.8 3.	Massive varieties usually have rough, crystalline surfaces and internal, radial fibrous structure. Color fades on exposure. In veins and cavities in basic igneous rocks. With pectolite, datolite, epidote, native copper, zeolites.
6. 7.	White	C—Prismatic F—Uneven, conchoidal Brittle	3.1 3.2	Small, transparent crystals, resembling green diopside. In cavities in granitic rocks. With beryl, monazite, rutile.
6. 7.	White	C—Pinacoidal F—Uneven Brittle	3.2 3.3	Crystals often bent, striated, edges rounded, without good terminations, and often interlaced. In metamorphic rocks—gneiss, mica schist. With andalusite, zircon, garnet, iolite.
6. 7.	White	C—Pinacoidal F—Conchoidal Brittle	3.3	Crystals sharp wedge-shaped, glassy, and frequently coated and intergrown with green chlorite. With quartz, adularia, albite, hornblende.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
EPIDOTE $Ca_2(Al,Fe)_2(Al.OH)(SiO_4)_3$	Monoclinic **C**—Prismatic, elongated and deeply striated parallel to *b* axis; usually terminated on one end only **M**—Columnar, fibrous, parallel and divergent; granular	Vitreous Transparent to opaque	Blackish gr Yellowish green Brownish green Pea green
***Diaspore** $AlO.OH$	Orthorhombic **C**—Broad columnar, tabular, rare **M**—Scaly, confused fibrous or bladed aggregates	Vitreous Pearly Transparent to translucent	Greenish Violet blue
CHLORITOID $H_2FeAl_2SiO_7$	Monoclinic **C**—Tabular, six-sided **M**—Foliated, scaly, platy; fan- and sheaf-like aggregates	Vitreous Pearly Translucent to opaque	Dark green Grayish gre Blackish green
CYANITE (Disthene, kyanite) Al_2SiO_5	Triclinic **C**—Long bladed, without good terminations; sometimes curved and radially grouped **M**—Coarsely bladed, columnar, fibrous	Vitreous Translucent to transparent	Sky blue Greenish bl Bluish whit
***ANDALUSITE** Al_2SiO_5	Orthorhombic **C**—Prismatic, rough, nearly square, often large and without terminations **M**—Columnar, fibrous, granular, disseminated.	Vitreous Dull Translucent to opaque	Pale green Olive green

* Uncommon color.

Hardness over 6

Hardness	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
6. 7.	White Grayish	C—Basal F—Uneven Brittle	3.3 3.5	Crystals are often dark or blackish green, massive aggregates lighter colored. With quartz, feldspar, garnet, hornblende, pyroxene, magnetite, native copper, zeolites.
6. 7.	White	C—Pinacoidal, conspicuous F—Conchoidal Very brittle	3.3 3.5	With corundum, emery, dolomite, margarite, chlorite, magnetite.
6. 7.	White Greenish white Grayish	C—Basal, perfect, conspicuous F—Scaly Brittle	3.4 3.6	Sometimes softer, due to alteration. Easily recognized by micaceous structure, perfect cleavage, and hardness. In clay slates, mica schists. With chlorite, hornblende, garnet, corundum.
6. 7.	White	C—Pinacoidal, perfect, conspicuous Brittle	3.5 3.7	Color irregularly distributed, frequently with lighter longitudinal margins. Hardness varies with direction, 4–5 parallel to long direction, 6–7 at right angles thereto. In gneiss, mica schist. With staurolite, corundum.
6. 7.5	White	C—Prismatic F—Uneven Brittle	3.1 3.2	Due to alteration, surfaces may be covered with scales of mica, hence, softer. In metamorphic rocks, often as rounded or knotty projections. With cyanite, sillimanite, garnet, tourmaline.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
VESUVIANITE $Ca_6[Al(OH,F)]Al_2(SiO_4)_5$	Tetragonal **C**—Short prismatic **M**—Compact, granular, aggregates with parallel or divergent striations	Vitreous Greasy Translucent to opaque	Green Brownish green Bluish
OLIVINE (Chrysolite, peridot) $(Mg,Fe)_2SiO_4$	Orthorhombic **C**—Prismatic, thick tabular **M**—Rounded, disseminated glassy grains; granular aggregates	Vitreous Transparent to translucent	Grass green Olive green Yellowish green
GARNET, varieties *Grossularite* $M_3''M_2'''(SiO_4)_3$ *Uvarovite* $M'' = Ca,Fe,Mg$ *Andradite* $M''' = Al,Fe,Cr$	Cubic **C**—Dodecahedrons, tetragonal trisoctahedrons, alone or in combination **M**—Granular, compact, lamellar, disseminated grains, sand	Vitreous Transparent to opaque	Pale green Grass green Emerald gr
QUARTZ, Crystalline varieties *Chloritic* SiO_2 *Cat's eye* *Amethyst*	Hexagonal **C**—Prismatic, horizontally striated **M**—Compact, granular	Vitreous Greasy Transparent to opaque	Green Greenish bl Blue Blue violet
Cryptocrystalline varieties *Chalcedony* *Chrysoprase* *Prase* *Plasma* *Heliotrope*	Hexagonal **C**—Never in crystals **M**—Nodular, spotted, concretionary, stalactitic, compact	Waxy Vitreous Translucent to opaque	Light green Dark green Grayish blu Greenish bl
*Boracite $Mg_7Cl_2B_{16}O_{30}$	Pseudocubic **C**—Tetrahedral, cubical, small, well developed **M**—Compact, nodular, fine fibrous	Vitreous Transparent to opaque	Greenish Bluish

* Uncommon color.

Hardness over 6

Hardness	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
6.5	White	**C**—Basal, prismatic, indistinct **F**—Uneven Brittle	3.3 3.5	In crystalline limestone, gneiss, schists. With garnet, tourmaline, chondrodite, wollastonite, epidote, pyroxene.
6.5 **7.**	White Yellowish white	**C**—Pinacoidal, indistinct **F**—Conchoidal Brittle	3.2 3.6	In basic rocks—basalts, traps; crystalline limestones. With augite, magnetite, spinel, plagioclase, chromite, pyrope.
6.5 **7.5**	White	**C**—Dodecahedral, usually indistinct **F**—Conchoidal, uneven Brittle	3.4 4.3	*Grossularite,* in crystalline limestones and dolomites, with wollastonite, vesuvianite, diopside, scapolite; *uvarovite,* in serpentine, with chromite, or in crystalline limestones; *andradite,* with feldspar, nephelite, leucite, epidote, magnetite.
7.	White	**C**—Indistinct **F**—Conchoidal, conspicuous Brittle	2.6	Characteristic conchoidal fracture and glassy luster. *Chloritic quartz,* green from included chlorite; *cat's eye,* opalescent, due to included fibers of asbestos; *amethyst,* purple or blue violet, usually in crystals.
7.	White	**C**—Indistinct **F**—Conchoidal, conspicuous Brittle to tough	2.6	Not as glassy as crystalline varieties, *Chalcedony, chrysoprase, prase, plasma,* uniform in color; *heliotrope,* spotted. To distinguish, see references.
7.	White	**C**—None **F**—Uneven, conchoidal Brittle	2.9 3.	Disseminated glassy crystals; compact masses resemble fine grained marble. With gypsum, anhydrite, halite, carnallite.

Streak—Uncolored, white or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
DUMORTIERITE $HBAl_8Si_3O_{20}$	Orthorhombic **C**—Prismatic, pseudo-hexagonal, small **M**—Fibrous, columnar	Vitreous Silky Transparent to translucent	Lavender blu Greenish blu Dark blue
Iolite (Cordierite) $(Mg,Fe)_4Al_8(OH)_2(Si_2O_7)_5$	Orthorhombic **C**—Short prismatic, pseudohexagonal **M**—Compact, disseminated, granular	Vitreous Dull Transparent to translucent	Light blue Violet blue Smoky blue Greenish blu
TOURMALINE $M'_{20}B_2Si_4O_{21}$ M′ = Na,K,Li,Mg, Ca,(OH),Fe Al	Hexagonal **C**—Prismatic, vertically striated; terminated with broken or rhombohedral-like surfaces **M**—Compact, columnar	Vitreous Transparent to translucent	Green Blue
BERYL, varieties *Emerald* $Be_3Al_2(SiO_3)_6$ *Aquamarine* *Common*	Hexagonal **C**—Long prismatic, often vertically striated, large **M**—Columnar, granular, compact, rounded pebbles	Vitreous Transparent to translucent	Pale green Emerald gre Bluish green Sky blue
ZIRCON $ZrSiO_4$	Tetragonal **C**—Prismatic, pyramidal, small, well developed **M**—Irregular lumps, grains	Adamantine Vitreous Resinous Transparent to opaque	Light blue Dark blue
SPINEL, varieties *Chlorospinel* $M''(M'''O_2)_2$ *Pleonaste* M″ = Mg,Fe, *Gahnite* Zn,Mn *Blue spinel* M‴ = Al,Fe	Cubic **C**—Octahedral, usually well developed **M**—Compact, granular, disseminated grains	Vitreous Dull Translucent to opaque	Grass green Dark green Grayish gre Light blue

Hardness over 6

Hardness	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
7.	White Bluish white	C—Pinacoidal, distinct F—Conchoidal Brittle	3.3	In pegmatites, veins, and lenticular masses. With quartz, muscovite, andalusite, cyanite. At times in radial aggregates.
7. 7.5	White	C—Pinacoidal, sometimes conspicuous F—Uneven Brittle	2.6 2.7	When fresh, glassy and hard, resembling blue quartz; usually altered, then dull and softer. Transparent varieties may show dichroism macroscopically. With quartz, feldspar, hornblende, sillimanite, andalusite.
7. 7.5	White	C—None F—Conchoidal, uneven Brittle	2.9 3.2	Spherical triangular cross-section. With zonal distribution of color—green, red, colorless. In igneous and metamorphic rocks. With lepidolite, feldspar, quartz, biotite.
7.5 8.	White	C—Indistinct F—Conchoidal, uneven Brittle	2.6 2.8	Crystals usually simple—prism and base. *Emerald*, transparent and emerald green; *aquamarine*, transparent, bluish to sea green or yellowish green. In granitic rocks, mica schists, clay slates, placers. With quartz, feldspar, mica, topaz, tourmaline, cassiterite, chrysoberyl, garnet.
7.5	White	C—Indistinct F—Uneven Brittle	4.4 4.8	In alluvial deposits near Bangkok, Siam. *Starlite*, clear and transparent, used as a gem.
7.5 8.	White Grayish	C—Octahedral, indistinct F—Conchoidal Brittle	3.5 4.4	Commonly as contact mineral in granular limestones; in more basic igneous rocks; rounded grains in placers. With calcite, chondrodite, serpentine, brucite, corundum, graphite, pyroxenes.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
*TOPAZ $Al_2(F,OH)_2SiO_4$	Orthorhombic **C**—Prismatic, vertically striated, highly modified **M**—Compact, granular, rolled fragments	Vitreous Transparent to opaque	Pale blue Bluish green Light green
Chrysoberyl, varieties *Ordinary* *Alexandrite* *Cat's eye* $Be(AlO_2)_2$	Orthorhombic **C**—Tabular; heart-shaped, pseudohexagonal twins **M**—Compact; loose, rounded grains	Vitreous Greasy Transparent to tranclucent	Light green Yellowish green Emerald gre
CORUNDUM, varieties *Sapphire* *Oriental emerald* *Oriental amethyst* *Common* Al_2O_3	Hexagonal **C**—Prismatic, tabular, pyramidal, rhombohedral; rough or rounded barrel-shaped **M**—Compact, granular, lamellar	Vitreous Transparent to opaque	Green Blue Blue violet

* Uncommon color.

Hardness over 6

Hardness	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
8.	White	**C**—Basal, usually conspicuous **F**—Conchoidal, uneven Brittle	3.4 3.6	Crystals usually developed on one end only. Color may fade on exposure. In veins and cavities in granitic rocks; alluvial deposits. With cassiterite, tourmaline, apatite, beryl, scheelite, wolframite.
8.5	White	**C**—Brachypinacoidal **F**—Uneven, conchoidal Brittle	3.6 3.8	Crystals disseminated as plates with feather-like or radial striations. *Alexandrite*, red in transmitted light; *cat's eye*, opalescent. In mica schist, gneiss, granite; also in placers. With beryl, garnet, tourmaline, sillimanite.
9.	White	**C**—None; nearly rectangular basal and rhombohedral partings, conspicuous; often striated **F**—Conchoidal Brittle to tough	3.9 4.1	When massive, often multi-colored—red, gray, yellow. *Sapphire*, transparent, blue; *oriental emerald*, green transparent; *oriental amethyst*, violet. In limestone, granite, syenite, schist, peridotite; placers. With magnetite, nephelite, mica, chlorite, spinel.

Streak—Red, brown, yellow, or black

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Carnotite $K_2O.2U_2O_3.V_2O_5.3H_2O$?	Orthorhombic **C**—Tabular, small rhombic plates **M**—Scaly aggregates, incrustations, crystalline powder	Resinous Vitreous Dull Transparent to translucent	Canary yellow Greenish yellow
BAUXITE $Al_2O(OH)_4$	Never in crystals **M**—Pisolitic, oolitic, round disseminated grains, clay-like, earthy	Dull Earthy Opaque	Yellow Yellowish brown Brown
LIMONITE, varieties *Yellow ocher* $Fe_2O_3.nH_2O$ *Brown ocher* *Bog iron ore* *Brown clay ironstone*	**M**—Earthy, porous, clay-like, oolitic, pisolitic Ocherous varieties may soil fingers	Earthy Dull Opaque	Yellow Yellowish brown Dark brown
Wad MnO_2,H_2O, etc.	Amorphous? **M**—Earthy, sometimes with globular structure	Dull Submetallic Opaque	Brown Blackish brown
ORPIMENT As_2S_3	Monoclinic **C**—Rare **M**—Foliated, granular, reniform, fibrous, crusts	Greasy Pearly Translucent	Lemon yellow
REALGAR AsS	Monoclinic **C**—Short prismatic, rare **M**—Compact, granular, incrustations	Resinous Transparent to translucent	Reddish yellow Orange yellow
SULPHUR S	Orthorhombic **C**—Pyramidal, tabular **M**—Granular, fibrous, earthy, crusts, compact	Greasy Adamantine Translucent	Straw yellow Brownish yellow Reddish yellow

Hardness 1 to 3

Hardness	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
1. **2.**	Yellow	**C**—Basal, perfect **F**—Earthy Brittle		Occurs as a powder or in loosely cohering masses, intimately mixed with sand and sandstones. With malachite, azurite, biotite, magnetite.
1. **3.**	Yellow Brown	**F**—Earthy Brittle	2.5 2.6	Color and streak variable. Clay odor, when breathed upon. Commonly pisolitic or oolitic. With clay or kaolinite, in nodules, grains, or irregular masses.
1. **3.**	Yellowish brown Dark brown	**F**—Earthy	3.4 4.	*Yellow ocher*, earthy, and yellow, when impure gritty; *brown ocher*, earthy and brown; *bog iron ore*, porous; *brown clay ironstone*, massive or concretionary, impure from clay, sand.
1. **3.**	Dark brown Black	**F**—Earthy	3. 4.3	May soil fingers. Apparently light and floats on water, due to porosity; usually adheres to tongue. With psilomelane, rhodochrosite, pyrolusite, limonite.
1.5 **2.**	Lemon yellow	**C**—Clinopinacoidal, usually conspicuous Slightly sectile, laminæ flexible	3.4 3.5	Characteristic lemon yellow color. Frequently disseminated in clay or dolomite. With realgar, stibnite, barite, calcite.
1.5 **2.**	Orange yellow	**C**—Clinopinacoidal, basal **F**—Conchoidal Slightly sectile	3.4 3.6	Redder in color than orpiment. Disseminated in clay or dolomite. With orpiment, stibnite, native arsenic, pyrite, barite, calcite.
1.5 **2.5**	Pale yellow	**C**—Indistinct **F**—Conchoidal Brittle	1.9 2.1	Independent beds in gypsum, limestone; in lava, result of volcanic exhalations. With celestite, anhydrite, aragonite, clay, metallic sulphides.

Streak—Red, brown, yellow, or black

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Copiapite (Misy) $Fe_2(Fe.OH)_2(SO_4)_5.18H_2O$	Monoclinic **C**—Tabular, six-sided, rare **M**—Granular, scales, powder	Pearly Dull Translucent to opaque	Sulphur yellow Greenish yellow Brownish yellow
CINNABAR HgS	Hexagonal **C**—Small, rhombohedral, thick tabular, rare **M**—Fine granular, fibrous, earthy coatings	Dull Adamantine Translucent to transparent	Reddish brown
*Olivenite $Cu(Cu.OH)AsO_4$	Orthorhombic **C**—Prismatic, acicular **M**—Reniform, fibrous, with velvety surface; earthy	Vitreous Dull Transparent to opaque	Brown Yellow
Wulfenite $PbMoO_4$	Tetragonal **C**—Square, thin tabular; more rarely pyramidal **M**—Coarse, fine grained	Greasy Adamantine Transparent to translucent	Wax yellow Orange yell Brown
Vanadinite $Pb_5Cl(VO_4)_3$	Hexagonal **C**—Prismatic, small, at times skeletal **M**—Compact, globular, fibrous, crusts	Greasy Translucent to opaque	Straw yellow Brownish yellow Reddish brown

Streak—Red, brown, yellow, or black

Greenockite CdS	Hexagonal **C**—Small, rare **M**—Earthy coatings	Adamantine Greasy Translucent	Honey yello Orange yell Greenish yellow

* Uncommon color.

Hardness 1 to 3

Hardness	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
1.5 **2.5**	Yellowish	**C**—Pinacoidal **F**—Earthy, scaly Brittle	2.1	Disagreeable metallic taste. Oxidation product of iron sulphide minerals—pyrite, marcasite, pyrrhotite.
2. **2.5**	Reddish brown	**C**—Prismatic, not conspicuous **F**—Uneven Brittle to sectile	8. 8.2	Dark color and streak due to impurities. High specific gravity often reduced by gangue. Disseminated in silicious rocks. With native mercury, pyrite, marcasite, realgar, stibnite.
3.	Brownish Yellowish	**C**—None **F**—Conchoidal, uneven Brittle	4.1 4.6	Some varieties soil fingers. Divergent, fibrous structure, and velvety surface important. With copper minerals.
3.	Lemon yellow Pale yellow	**C**—Indistinct **F**—Conchoidal, uneven Brittle	6.3 7.	Square plates, sometimes with forms of the third order. With lead minerals—galena, pyromorphite, vanadinite.
3.	Pale yellow Yellow	**C**—None **F**—Conchoidal, uneven Brittle	6.7 7.2	Crystal faces smooth with sharp edges. With lead minerals, but never in large quantities.

Hardness over 3

3. **3.5**	Orange yellow	**C**—Prismatic, basal, not conspicuous Brittle	4.9 5.	Usually as bright yellow powder on sphalerite. With smithsonite, prehnite, galena, calcite.

Streak—Red, brown, yellow, or black

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
LIMONITE, varieties *Compact* *Bog iron ore* $Fe_2O_3.nH_2O$ *Brown clay* *ironstone*	**C**—Always pseudomorphs, commonly after pyrite, marcasite, siderite **M**—Compact, stalactitic, botryoidal, nodular; often with internal, radial fibrous structure; porous, pisolitic, oolitic	Metallic Dull Opaque	Yellowish brown Dark brown
SIDERITE $FeCO_3$	Hexagonal **C**—Rhombohedral, curved or saddle-shaped **M**—Cleavable, granular, compact, botryoidal, rarely fibrous	Vitreous Pearly Dull Translucent to nearly opaque	Light brown Reddish brown Dark brown
SPHALERITE ZnS	Cubic **C**—Tetrahedral, common **M**—Cleavable, fine or coarse grained, compact	Resinous Submetallic Transparent to opaque	Honey yellow Yellowish brown Reddish brown
PYROMORPHITE $Pb_5Cl(PO_4)_3$	Hexagonal **C**—Prismatic, thick tabular, rounded and barrel-shaped acicular **M**—Globular, reniform, disseminated, crusts	Greasy Adamantine Translucent to opaque	Wax yellow Green yellow Yellowish brown
Zincite ZnO	Hexagonal **C**—Small, rare **M**—Compact, granular, foliated	Adamantine Vitreous Translucent to opaque	Orange yello Reddish yellow
Xenotime YPO_4	Tetragonal **C**—Pyramidal, prismatic **M**—Compact, disseminated, rolled grains	Greasy Vitreous Translucent to opaque	Yellowish brown Reddish brown Pale yellow

Hardness over 3

Hardness	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
3. **5.5**	Yellowish brown	**F**—Conchoidal, splintery, earthy Brittle	3.4 4.	Often with black varnish-like surface and passing into soft, yellow ocherous variety. *Compact limonite*, massive with fibrous structure, rather pure; *bog iron ore*, porous; *brown clay ironstone*, massive or concretionary, impure from clay, sand.
3.5 **4.**	Pale yellow Yellowish brown	**C**—Rhombohedral, conspicuous **F**—Conchoidal Brittle	3.7 3.9	Curved crystals and rhombohedral cleavage characteristic. In ore deposits; beds and concretions in limestones and shales. With pyrite, chalcopyrite, galena, tetrahedrite, cryolite.
3.5 **4.**	Pale yellow Light brown	**C**—Dodecahedral, usually conspicuous **F**—Conchoidal Brittle	3.9 4.2	Distinguished from siderite by crystallization, more resinous luster, and cleavage. Color and streak vary with impurities. Extensively in limestones. With galena, chalcopyrite, pyrite, rhodochrosite, barite, fluorite.
3.5 **4.**	Yellow Greenish yellow	**C**—None **F**—Conchoidal, uneven Brittle	6.5 7.1	Common alteration product of lead minerals. With galena cerussite, mimetite, barite, limonite.
4. **4.5**	Orange yellow Reddish yellow	**C**—Basal, sometimes conspicuous **F**—Uneven Brittle	5.4 5.7	Recognized by associates. With calcite, franklinite (black), willemite (yellow to green), rhodonite (flesh red.) On exposure becomes coated with the white carbonate.
4. **5.**	Pale brown Yellowish	**C**—Prismatic **F**—Uneven, splintery Brittle	4.4 4.6	Commonly as loose, disseminated, or attached crystals resembling zircon but softer. In granite, gneiss, with zircon; alluvial deposits.

Streak—Red, brown, yellow, or black

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
ORANGITE (Thorite) $ThSiO_4$	Tetragonal **C**—Square prisms with bipyramids **M**—Compact, disseminated	Greasy Vitreous Transparent to translucent	Orange yellow Brownish yellow Dark brown
Goethite FeO.OH	Orthorhombic **C**—Small, thin tabular, nedele-like; parallelly grouped **M**—Reniform, stalactitic	Adamantine Dull Translucent to opaque	Yellow Yellowish brown Dark brown
Huebnerite $MnWO_4$	Monoclinic **C**—Long fibrous, bladed, stalky; often divergent **M**—Compact, lamellar, granular	Greasy Submetallic Translucent to opaque	Reddish brown Hair brown Pale yellow
WOLFRAMITE $(Fe,Mn)WO_4$	Monoclinic **C**—Thick tabular, short columnar, often large **M**—Bladed, curved lamellar, granular	Submetallic Opaque	Reddish brow Dark brown
Ferberite $FeWO_4$	Monoclinic **C**—Wedge shaped, short prismatic, tabular **M**—Bladed, fan shaped; granular, compact	Submetallic Opaque	Brown Blackish brown
***Orthite** (Allanite) $Ca_2(Al,Ce,Fe)_2(Al.OH)(SiO_4)_3$	Monoclinic **C**—Tabular, rare **M**—Compact, granular, bladed, disseminated grains	Greasy Submetallic Translucent to opaque	Dark brown Blackish brown Yellowish brown
Brookite TiO_2	Orthorhombic Only in crystals,—pyramidal (often with hexagonal habit), prismatic, tabular	Adamantine Metallic Opaque	Dark brown Reddish bro

* Uncommon color.

Hardness over 3

Hardness	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
4.5 **5.**	Light orange Dark brown	C—Prismatic, not conspicuous F—Conchoidal Brittle	4.4 5.4	Yellow orangite sometimes surrounded by dark brown to black thorite, which is thought to be decomposed orangite.
4.5 **5.5**	Yellow Yellowish brown	C—Brachypinacoidal F—Uneven, splintery Brittle	4. 4.4	Usually with other iron minerals; in cavities in hematite or limonite. Crystals and cleavage distinguish it from limonite. Often as scaly, fibrous, velvety crusts.
4.5 **5.5**	Yellowish brown	C—Clinopinacoidal, conspicuous Brittle	6.7 7.3	Structure, cleavage, and high specific gravity characteristic. In quartz veins. With wolframite, fluorite, pyrite, scheelite, galena, tetrahedrite.
5. **5.5**	Reddish brown Dark brown	C—Clinopinacoidal, conspicuous F—Uneven Brittle	7.1 7.5	Distinguished from huebnerite by streak. Powder may be slightly magnetic. With cassiterite, quartz, mica, apatite, scheelite, molybdenite, huebnerite.
5. **5.5**	Brown Dark brown	C—Clinopinacoidal, perfect F—Uneven Brittle	7.5	In granites and pegmatites. With quartz, chalcopyrite, galena, scheelite.
5.5 **6.**	Pale brown Grayish brown	C—Indistinct F—Uneven, conchoidal Brittle	3. 4.	Often covered with yellowish or brownish alteration product. Disseminated in igneous rocks; also in limestones. With magnetite, epidote, quartz, feldspar.
5.5 **6.**	Yellowish Brownish	C—Indistinct F—Uneven Brittle	3.8 4.1	Crystals may be striated; not twinned like rutile. With anatase, titanite, rutile, adularia, nephelite.

Streak—Red, brown, yellow, or black

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
RUTILE TiO_2 or $TiTiO_4$	Tetragonal **C**—Prismatic, vertically striated; twinned yielding knee-shaped or rosette forms **M**—Compact, disseminated	Adamantine Submetallic Translucent to opaque	Reddish br Yellowish brown Dark brow
CASSITERITE SnO_2 or $SnSnO_4$	Tetragonal **C**—Thick prismatic; knee-shaped twins quite common **M**—Compact, reniform, botryoidal, rounded pebbles, often with internal, radial fibrous structure,—*wood tin*	Adamantine Greasy Dull Translucent to opaque	Reddish Yellowish brown Dark brow
SPINEL, variety *Picotite* $(Mg,Fe)_2(Al,Cr)_2O_4$	Cubic **C**—Octahedral, small **M**—Compact, granular, disseminated grains	Vitreous Dull Nearly opaque	Yellowish brown Greenish brown Brown

Streak—Uncolored, white, or light gray

Cerargyrite (Horn silver) AgCl	Cubic **C**—Rare **M**—Wax-like crusts and coatings; stalactitic, dendritic	Waxy Greasy Transparent to translucent	Yellowish Brownish
Carnallite $MgCl_2.KCl.6H_2O$	Orthorhombic **C**—Pseudohexagonal, rare **M**—Compact, granular	Vitreous Dull Transparent to translucent	Yellowish Brownish
Pyrophyllite $H_2Al_2Si_4O_{12}$	Orthorhombic? **C**—Indistinct **M**—Radiated fibrous, or lamellar aggregates; granular, compact	Greasy Dull Translucent to opaque	Brownish Yellowish

Hardness over 3

Hard-ness	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
6. 7.	Pale yellow Pale brown	C—Prismatic, pyramidal, not conspicuous F—Uneven Brittle	4.2 4.3	Not as heavy as cassiterite. Often in fine hair-like inclusions. With quartz, feldspar, hematite, ilmenite, chlorite, brookite.
6. 7.	Pale brown Pale yellow	C—Indistinct F—Uneven Brittle	6.8 7.2	Recognized by high specific gravity. In veins cutting granite, gneiss; in alluvial deposits as *stream tin*. With quartz, mica, wolframite, arsenopyrite, molybdenite, tourmaline, fluorite, chlorite.
7.5 8.	Pale brown	C—Indistinct F—Conchoidal Brittle	4.1	Commonly in basic igneous rocks, especially olivine-bearing types. With serpentine, olivine, corundum, magnetite, garnet.

Hardness 1 to 3

1. 1.5	White, shiny Gray, shiny	C—None F—Conchoidal Highly sectile	5.5 5.6	Cuts like wax, yielding shiny surfaces; on exposure turns violet, brown, or black. With silver minerals, especially argentite, native silver; also limonite, calcite, barite.
1. 2.	White	C—Indistinct F—Conchoidal Brittle	1.6	Bitter taste. Absorbs moisture. With halite, kieserite, kainite, sylvite, anhydrite.
1. 2.	White Yellowish white	C—Longitudinal F—Fibrous, uneven Laminæ flexible	2.8 2.9	Soft and greasy like talc, but usually in radiating fibers. In schistose rocks. With cyanite, lazulite, topaz, graphite.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Calomel $HgCl$	Tetragonal **C**—Tabular, pryamidal, small **M**—Coatings	Adamantine Translucent to nearly opaque	Yellowish Brown
TRIPOLITE (Opal) $SiO_2.nH_2O$	Amorphous **M**—Porous, earthy, chalk-like	Vitreous Dull Translucent to opaque	Yellow Yellowish brown Brown
KAOLINITE (Kaolin) $H_4Al_2Si_2O_9$	Monoclinic **C**—Scaly, hexagonal or orthorhombic outline, rare **M**—Compact, friable, mealy, clay-like	Dull Pearly Earthy Opaque to translucent	Yellowish Brownish
TALC, variety *Soapstone* or *steatite* $H_2Mg_3Si_4O_{12}$	Monoclinic **M**—Compact, globular, granular	Greasy Pearly Translucent to opaque	Yellowish Yellowish brown Brownish
Asbestos, variety *Chrysotile* $H_4Mg_3Si_2O_9$	Orthorhombic ? **M**—Fibrous, coarse or fine; felted	Silky Greasy Opaque	Yellowish Brownish
variety *Amphibole* Silicate of Ca, Mg, Fe, Al, etc.	Monoclinic **M**—Fibrous, coarse or fine; felted; compact, leather- or cork-like	Silky Dull Opaque	Yellowish Brownish

Hardness 1 to 3

Hardness	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
1. 2.	White Gray	C—Indistinct F—Conchoidal Very sectile	6.4 6.5	Characterized by high specific gravity and associates. With mercury minerals—cinnabar, native mercury; barite, quartz, tetrahedrite.
1. 2.5	White Gray	F—Earthy Friable	2.1 2.3	Apparently very soft, but fine particles scratch glass. Resembles kaolinite, but gritty and not plastic. Due to impurities may have clay odor.
1. 2.5	White Yellowish white	C—Basal,—scales F—Earthy Brittle	2.2 2.6	Not gritty like tripolite. Very strong clay odor when breathed upon. Usually adheres to tongue and becomes plastic when moistened. Greasy feel. With quartz, feldspar, corundum, diaspore, topaz.
1. 2.5	White Yellowish white	F—Uneven, splintery Sectile	2.6 2.8	Greasy or soapy feel important. *Soapstone* or *steatite,* coarse to fine granular, more or less impure. Hardness varies. With serpentine, chlorite, dolomite magnesite, actinolite.
1. 3.	White	F—Fibrous Flexible	1. 2.5	Delicate, fine, parallel, flexible fibers perpendicular to walls, easily separable,—*short fibered asbestos,* compare below. In veins or seams in compact serpentine.
1. 3.	White	F—Fibrous Flexible, tough	1. 2.5	*Long fibered asbestos,* parallel, flexible fibers, parallel to walls. Compare above. *Mountain leather, mountain cork, mountain wood,* compact but light and tough

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
SAL AMMONIAC NH_4Cl	Cubic **C**—Distorted, rare **M**—Fibrous, powdery, stalactitic, crusts	Vitreous Transparent to translucent	Yellow Yellowish brown Brown
Struvite $NH_4MgPO_4.6H_2O$	Orthorhombic **C**—Domatic, hemimorphic **M**—Granular, earthy	Vitreous Dull Translucent to opaque	Brownish Yellowish
SODA NITER (Chile saltpeter) $NaNO_3$	Hexagonal **C**—Rare **M**—Granular, crusts, efflorescences	Vitreous Transparent	Yellowish Lemon yell Reddish br
GYPSUM, varieties *Selenite* $CaSO_4.2H_2O$ *Satin spar* *Ordinary*	Monoclinic **C**—Tabular, prismatic; swallow tail twins **M**—Cleavable, coarse and fine grained, fibrous, foliated, earthy	Pearly Vitreous Silky Dull Transparent to opaque	Yellow Honey yell Brown
SULPHUR S	Orthorhombic **C**—Pyramidal, tabular **M**—Compact, granular, fibrous, earthy, crusts	Adamantine Greasy Translucent	Straw yello Brownish yellow Reddish yellow
Amber (Succinite) $C_{40}H_{64}O_4$	Amorphous **M**—Irregular, stalactitic, grains, lumps	Greasy Transparent to translucent	Light yello Honey yell Brownish yellow
Sylvite KCl	Cubic **C**—Cubes, alone or with octahedron, rare **M**—Granular, compact	Vitreous Transparent to translucent	Yellow Reddish yellow

Hardness 1 to 3

ard-ess	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
.5 2.	White	C—Octahedral, indistinct F—Conchoidal Brittle	1.5	Pungent, salty taste, somewhat astringent. Usually sublimation product. Near volcanoes, burning coal beds, guano deposits.
.5 2.	White	C—Pinacoidal F—Conchoidal Brittle	1.7	Crystals coffin-shaped with pronounced hemimorphism. In sewers, vaults, guano deposits.
.5 2.	White	C—Rhombohedral F—Conchoidal Brittle	2.1 2.3	Cooling and saline taste. Absorbs moisture readily. In deposits with gypsum, sand, clay, guano.
.5 2.	White	C—Clinopinacoidal, conspicuous; pyramidal, orthopinacoidal F—Conchoidal, fibrous Brittle, laminæ flexible	2.2 2.4	*Selenite*, crystals and cleavable plates, usually transparent; *satin spar*, fibrous with silky luster; *ordinary*, granular. In limestones and shales. With halite, celestite, sulphur, aragonite, anhydrite; ore deposits.
.5 2.5	White Yellowish white	C—Indistinct F—Conchoidal Brittle	1.9 2.1	Independent beds in gypsum, limestone; in lava, result of volcanic exhalations. With celestite, anhydrite, aragonite, clay, metallic sulphides.
2. 2.5	White	F—Conchoidal Brittle	1. 1.1	Fossil resin. Electrified when rubbed. Often mottled and striped. Sometimes with inclusions—insects, vegetable remains, liquids, minerals.
2. 2.5	White	C—Cubic F—Conchoidal Brittle	1.9 2.	Color due to impurities. Salty bitter taste. May absorb moisture and become damp. In salt deposits. With halite, kainite, carnallite.

Streak—Uncolored, white, or, light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
HALITE (Rock salt) NaCl	Cubic **C**—Cubes, often skeletal or ho pper-shaped **M**—Compact, cleavable, granular, fibrous, stalactitic, crusts	Vitreous Transparent to translucent	Yellow Yellowish brown Brownish
MICAS PARAGONITE $H_2NaAl_3(SiO_4)_3$	Monoclinic **M**—Compact, fine scaly aggregates	Pearly Translucent	Yellowish
MUSCOVITE (Isinglass) $H_2KAl_3(SiO_4)_3$	Monoclinic **C**—Tabular, pyramidal, with rhombic or hexagonal outline; often large and rough **M**—Scales, plates; foliated and plumose aggregates	Vitreous Pearly Transparent to translucent	Light yellow Yellowish brown Light brown
PHLOGOPITE $(K,H)_3Mg_3Al(SiO_4)_3$	Monoclinic **C**—Prismatic, tabular, with hexagonal or rhombic outline; often large and coarse **M**—Plates, disseminated scales	Pearly Submetallic Transparent to translucent	Yellow Yellowish brown Brown
APATITE, variety *Phosphate rock* Mainly calcium carbonate—phosphate (collophane)	Amorphous **M**—Compact, fibrous, nodular, reniform, earthy	Dull Opaque	Brown
GRÜNERITE (Amphibole) $H_2Fe_7(SiO_3)_8$	Monoclinic **C**—Fine acicular **M**—Fibrous, lamellar	Silky Translucent to opaque	Brownish
Glauberite $Na_2SO_4.CaSO_4$	Monoclinic **C**—Thick tabular **M**—Reniform, lamellar	Greasy Vitreous Transparent to translucent	Pale yellow Yellow

Hardness 1 to 3

ard-ess	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
2. 2.5	White	C—Cubic, perfect, conspicuous F—Conchoidal Brittle	2.1 2.3	Pigment usually iron oxide. May absorb moisture and become damp. Characteristic cubical cleavage and saline taste. With shale, gypsum, anhydrite, polyhalite.
2. 3.	White	C—Basal, perfect F—Scaly, granular Tough	2.8 2.9	Distinguished from other micas by associates—cyanite, staurolite, tourmaline.
2. 3.	White	C—Basal, perfect, conspicuous Tough, laminæ very elastic	2.8 3.1	Lighter colored than phlogopite. Structure, perfect cleavage, and elasticity important. Crystals may show distinct partings perpendicular to cleavage—*ruled mica.* In granitic rocks, schists, limestones. With feldspar, quartz, tourmaline, beryl, garnet.
2. 3.	White	C—Basal, perfect, conspicuous Tough, laminæ very elastic	2.8 3.1	Usually amber brown or bronze in color. When cleavage laminæ are held close to the eye in viewing a source of light a star-like form is sometimes observed. Especially characteristic of crystalline limestones, dolomites, schists. With pyroxenes, amphiboles, serpentine.
2. 3.	White	F—Conchoidal, uneven Brittle	3.1 3.2	More or less impure masses, frequently resembling compact limestone. Independent beds, nodules, concretions.
2. 3.	White	C—Fibrous Brittle	3.7	Usually with quartz, magnetite, and called *magnetite-grünerite schist.*
2.5	White	C—Basal F—Conchoidal Brittle	2.7 2.8	Bitter, saline taste. On exposure becomes coated with white powdery crust. With halite, thenardite, mirabilite.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Leadhillite $PbSO_4.2PbCO_3.Pb(OH)$	Monoclinic **C**—Tabular, pseudohexagonal; twins and trillings **M**—Compact, lamellar	Greasy Adamantine Transparent to translucent	Yellow Brown
Kainite $MgSO_4.KCl.3H_2O$	Monoclinic **C**—Tabular, prismatic, rare **M**—Compact, fine grained	Vitreous Transparent to translucent	Yellow
*Gibbsite (Hydrargillite) $Al(OH)_3$	Monoclinic **C**—Pseudohexagonal, tabular, rare **M**—Stalactitic, mammillary, surface smooth, internal structure fibrous; scaly aggregates	Vitreous Pearly Translucent	Yellowish
***CRYOLITE** Na_3AlF_6	Monoclinic **C**—Pseudocubical, small, rare **M**—Cleavable, compact, granular	Vitreous Greasy Transparent to translucent	Grayish brown Dark brow
BARITE (Heavy spar) $BaSO_4$	Orthorhombic **C**—Tabular, prismatic, very common; crested divergent groups **M**—Compact, lamellar, fibrous, cleavable, reniform	Vitreous Pearly Transparent to opaque	Yellowish Brownish Dark brow
***Allophane** $Al_2SiO_5.5H_2O$	Amorphous **M**—Reniform, mammillary, stalactitic, incrustations	Vitreous Greasy Translucent	Brown Yellow
Kieserite $MgSO_4.H_2O$	Monoclinic **C**—Pyramidal, rare **M**—Compact, granular	Vitreous Transparent to translucent	Yellow

* Uncommon color.

Hardness 1 to 3

ard-ess	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
2.5	White	C—Basal, perfect F—Conchoidal, rarely observed Rather sectile	6.2 6.4	Soft and very heavy. Twins and trillings resemble those of aragonite. Sparingly with lead minerals. Pseudomorphous after calcite, galena.
2.5 3.	White	C—Pinacoidal, prismatic, not conspicuous F—Uneven Brittle	2. 2.2	Taste, salty, bitter and astringent. Non-hygroscopic. With halite, sylvite.
2.5 3.	White	C—Indistinct Tough	2.3 2.4	Slight clay odor when breathed upon. With bauxite, natrolite, limonite, corundum.
2.5 3.	White	C—Basal, prismatic, perfect, nearly at 90°; sometimes conspicuous F—Uneven Brittle	2.9 3.	Often contains disseminated siderite, chalcopyrite, galena, pyrite, fluorite, columbite.
2.5 3.	White	C—Basal, prismatic, usually conspicuous F—Uneven Brittle	4.3 4.7	Characterized by rather high specific gravity and cleavages. In metalliferous veins; pockets, lenticular masses in limestones. With galena, sphalerite, fluorite, chalcopyrite; manganese and iron minerals.
3.	White	F—Conchoidal, earthy Brittle	1.9	Structure resembles opal. In fissures and cavities with iron and copper minerals.
3.	White	C—Pyramidal F—Granular Friable to firm	2.5 2.6	Due to absorption of water becomes coated with white crust of epsomite. With halite, potassium salts—carnallite, kainite, sylvite.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
CALCITE, varieties *Dog tooth spar* $CaCO_3$ *Nail head spar* *Anthraconite* *Limestone* *Marble* *Calcareous tufa* *Travertine* *Stalactites, etc.* *Thinolite*	Hexagonal **C**—Scalenohedral, rhombohedral, prismatic; tabular, acicular; may be highly modified and twinned **M**—Cleavable, granular, fibrous, banded, stalactitic, oolitic, porous, compact, crusts, shells	Vitreous Dull Transparent to nearly opaque	Honey yell Yellowish brown Dark brow
Wulfenite $PbMoO_4$	Tetragonal **C**—Square, thin tabular; more rarely pyramidal **M**—Coarse, fine grained	Greasy Adamantine Transparent to translucent	Wax yellow Orange ye Brown
Vanadinite $Pb_5Cl(VO_4)_3$	Hexagonal **C**—Prismatic, small, at times skeletal **M**—Compact, globular, fibrous, crusts	Greasy Translucent to opaque	Straw yell Brownish yellow Reddish brown

Streak—Uncolored, white or light gray

***Gibbsite** (Hydrargillite) $Al(OH)_3$	Monoclinic **C**—Pseudohexagonal, tabular, rare **M**—Stalactitic, mammillary, surface smooth, internal structure fibrous; scaly aggregates	Vitreous Pearly Translucent	Yellowish
Polyhalite $K_2MgCa_2(SO_4)_4.2H_2O$	Monoclinic ? **C**—Indistinct **M**—Compact, fibrous, lamellar	Greasy Pearly Translucent	Yellowish

* Uncommon color.

Hardness 1 to 3

Hardness	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
3.	White	C—Rhombohedral usually conspicuous F—Conchoidal Brittle	2.7	Often in extensive deposits. Rhombohedral cleavage characteristic especially on crystals. Cleavage surfaces often striated. Very strong double refraction easily observed when transparent. To distinguish varieties, see references.
3.	White Yellowish white	C—Pyramidal, indistinct F—Conchoidal, uneven Brittle	6.3 7.	Square plates sometimes with forms of the third order. With lead minerals—galena, pyromorphite, vanadinite.
3.	White Yellowish white	C—None F—Conchoidal, uneven Brittle	6.7 7.2	Crystal faces smooth with sharp edges. With lead minerals, but never in large quantities.

Hardness 3 to 6

3. 3.5	White	C—Indistinct Tough	2.3 2.4	Slight clay odor when breathed upon. With bauxite, natrolite, limonite, corundum.
3. 3.5	White	F—Stalky, fibrous Brittle	2.7 2.8	Taste, bitter and astringent, but weak. With halite, anhydrite, gypsum, clay.

Streak—Uncolored, white, or light gray

	Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
	***CELESTITE** $SrSO_4$	Orthorhombic **C**—Tabular, prismatic, common; pyramidal **M**—Compact, cleavable, fibrous, granular, reniform	Vitreous Pearly Transparent to translucent	Yellow Yellowish white
	BARITE (Heavy spar) $BaSO_4$	Orthorhombic **C**—Tabular, prismatic, very common; crested and divergent groups **M**—Compact, lamellar, fibrous, cleavable, reniform	Vitreous Pearly Transparent to opaque	Yellowish Brownish Dark brown
	***ANGLESITE** $PbSO_4$	Orthorhombic **C**—Prismatic, tabular, pyramidal **M**—Compact, granular, nodular	Greasy Adamantine Transparent to opaque	Yellow Brown
	CERUSSITE $PbCO_3$	Orthorhombic **C**—Tabular, prismatic, pyramidal; pseudo-hexagonal; clusters and star-shaped groups **M**—Interlaced bundles, granular, stalactitic, compact	Adamantine Greasy Silky Transparent to translucent	Yellow Yellowish brown
ZEOLITES	**Heulandite** $H_4CaAl_2(SiO_3)_6.3H_2O$	Monoclinic **C**—Tabular, striated **M**—Foliated, granular, globular	Vitreous Pearly Transparent to translucent	Brown Yellow
ZEOLITES	**STILBITE** (Desmine) $(Ca,Na_2)Al_2Si_6O_{16}.6H_2O$	Monoclinic **C**—Twinned, sheaf-like, radial, or globular aggregates	Vitreous Pearly Transparent to translucent	Yellowish Yellowish brown Brownish

* Uncommon color.

Hardness 3 to 6

Hardness	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
3. 3.5	White	C—Basal, prismatic, conspicuous F—Uneven Brittle	3.9 4.	Prominent cleavages. Heavier than calcite, lighter than barite. In limestones, dolomites, shales. With sulphur, gypsum, aragonite, halite, galena, sphalerite.
3. 3.5	White	C—Basal, prismatic, usually conspicuous F—Uneven Brittle	4.3 4.7	Characterized by rather high specific gravity and cleavages. In metalliferous veins; pockets, lenticular masses in limestone. With galena, sphalerite, fluorite, chalcopyrite; manganese and iron minerals.
3. 3.5	White	C—Basal, prismatic F—Conchoidal Brittle	6.1 6.4	Adamantine luster and very high specific gravity important. Distinguished from cerussite by absence of twins. Oxidation product of lead minerals. Usually in cracks and cavities. With galena, cerussite.
3. 3.5	White Gray	C—Indistinct F—Conchoidal Brittle	6.4 6.6	Twinning, structure, luster, and specific gravity characteristic. With lead minerals—galena, pyromorphite, anglesite; also malachite, limonite.
3. 4.	White	C—Clinopinacoidal, perfect F—Uneven Brittle	2.1 2.2	In basic igneous rocks and metalliferous veins. With chabazite, stilbite, apophyllite, datolite.
3. 4.	White	C—Pinacoidal, distinct F—Uneven Brittle	2.1 2.2	Radial and sheaf-like structure important. In basic igneous rocks and ore deposits. With heulandite, chabazite, apophyllite, datolite, calcite.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
*Laumontite (Zeolite) $Ca(Al.2OH)_2(Si_2O_5)_2.2H_2O$	Monoclinic C—Columnar M—Radial, divergent, earthy	Vitreous Dull Transparent to opaque	Yellowish Brownish
SERPENTINE $H_4Mg_3Si_2O_9$	Monoclinic C—Unknown M—Compact, columnar, fibrous, lamellar, granular	Greasy Waxy Translucent to opaque	Greenish brown Greenish yellow Yellowish brown
*Margarite $H_2CaAl_4Si_2O_{12}$	Monoclinic C—Six-sided scales, plates M—Scaly, platy; foliated, granular aggregates	Pearly Vitreous Translucent	Yellowish
APATITE, variety *Phosphate rock* Mainly calcium carbonate—phosphate (collophane)	Amorphous M—Compact, fibrous, nodular, reniform	Dull Opaque	Brown
Wavellite $(Al.OH)_3(PO_4)_2.5H_2O$	Orthorhombic C—Capillary, small M—Crusts, globular, hemispherical aggregates, with radial fibrous structure	Vitreous Translucent	Yellow Brown
DOLOMITE $CaMg(CO_3)_2$	Hexagonal C—Rhombohedral, with curved surfaces M—Coarsely crystalline, compact, granular, friable	Vitreous Transparent to translucent	Yellowish brown Grayish brown Dark brow

* Uncommon color.

Hardness 3 to 6

Hardness	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
3. 4.	White	C—Indistinct F—Uneven, earthy Brittle, friable	2.3	On exposure becomes dull and crumbles to powder. In cavities and fissures in basic igneous rocks. With stilbite, analcite, apophyllite, native copper.
3. 4.	White	F—Conchoidal, splintery Brittle	2.5 2.8	Smooth and greasy feel. Often spotted, clouded, multi-colored. Sometimes crossed by seams of asbestos (*chrysotile*). With magnesite, chromite, garnierite, pyrope, platinum, calcite.
3. 4.5	White	C—Basal, perfect, conspicuous F—Scaly, granular Brittle	3.	Resembles the micas in structure and cleavage, but harder; laminæ brittle and inelastic. With chlorite, emery, diaspore, corundum.
3. 5.	White	F—Conchoidal, uneven Brittle	3.1 3.2	More or less impure masses, frequently resembling compact, brown limestone. Independent beds, nodules, concretions.
3.5 4.	White	C—Pinacoidal, domatic F—Uneven, fibrous Brittle	2.3 2.4	Secondary mineral occurring on surfaces of rocks or minerals, as crystalline crusts with pronounced radial fibrous structure.
3.5 4.	White Gray	C—Rhombohedral, perfect (crystals) F—Conchoidal Brittle	2.9	Crystals generally curved or saddle-shaped. *Marble* includes some compact varieties. Independent beds; in fissures and cavities; with ore deposits.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
ARAGONITE $CaCO_3$	Orthorhombic **C**—Chisel- or spear-shaped; pseudohexagonal prisms; radial, columnar, acicular aggregates **M**—Stalactitic, reniform, crusts, oolitic	Vitreous Resinous Transparent to translucent	Wine yellow Yellowish brown
***Scorodite** $FeAsO_4.2H_2O$	Orthorhombic **C**—Prismatic, pyramidal, drusy **M**—Botryoidal, fibrous, crusts	Vitreous Greasy Translucent	Brown
STRONTIANITE $SrCO_3$	Orthorhombic **C**—Spear-shaped, columnar, acicular; often in divergent groups **M**—Granular, compact, botryoidal, fibrous	Vitreous Greasy Transparent to translucent	Yellow Yellowish brown Brown
SIDERITE $FeCO_3$	Hexagonal **C**—Rhombohedral, curved or saddle-shaped, common **M**—Cleavable, granular, compact, botryoidal, rarely fibrous	Vitreous Pearly Dull Translucent to nearly opaque	Light brow Reddish brown Dark brow
SPHALERITE ZnS	Cubic **C**—Tetrahedral, common **M**—Cleavable, fine and coarse grained, compact	Resinous Submetallic Translucent to opaque	Honey yell Yellowish brown Reddish br
PYROMORPHITE $Pb_5Cl(PO_4)_3$	Hexagonal **C**—Prismatic, thick tabular, rounded and barrel-shaped; acicular **M**—Globular, reniform, disseminated, crusts	Greasy Adamantine Translucent to opaque	Wax yellow Greenish yellow Yellowish brown

* Uncommon color.

Hardness 3 to 6

Hardness	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
3.5 4.	White Gray	C—Pinacoidal, prismatic F—Conchoidal Brittle	2.9 3.	Twins common, often pseudohexagonal—prism and striated base. In cracks and cavities; with ore deposits; deposition from hot springs; in shells. With gypsum, celestite, sulphur, siderite, zeolites.
3.5 4.	White Grayish Brownish white	C—Indistinct F—Uneven, conchoidal Brittle	3.1 3.3	With arsenopyrite, enargite, limonite, pyrite.
3.5 4.	White Gray	C—Prismatic, indistinct F—Uneven Brittle	3.6 3.8	Structure similar to aragonite. Divergent columnar masses and higher specific gravity characteristic. In ore deposits; independent beds. With galena, barite, calcite.
3.5 4.	Gray White	C—Rhombohedral, conspicuous F—Conchoidal Brittle	3.7 3.9	Distinguished from sphalerite by curved crystals and rhombohedral cleavage. In ore deposits; beds and concretions in limestones and shales. With pyrite, chalcopyrite, galena, tetrahedrite, cryolite.
3.5 4.	White Yellowish white	C—Dodecahedral, usually conspicuous F—Conchoidal Brittle	3.9 4.2	Resinous luster and cleavage important. Color and streak vary with impurities. Extensively in limestones. With galena, chalcopyrite, pyrite, barite, fluorite, rhodochrosite, smithsonite.
3.5 4.	White Yellowish white	C—None F—Conchoidal, uneven Brittle	6.5 7.1	Common alteration product of lead minerals. With galena, cerussite, mimetite, barite, limonite.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Mimetite $Pb_5Cl(AsO_4)_3$	Hexagonal **C**—Prismatic, tabular, rounded, barrel-shaped **M**—Globular, reniform, crusts.	Greasy Adamantine Translucent	Orange yell Yellowish brown Brown
***RHODOCHROSITE** $MnCO_3$	Hexagonal **C**—Rhombohedral, rare **M**—Cleavable, granular, compact, botryoidal, crusts	Vitreous Translucent	Yellow Brown
***MAGNESITE** $MgCO_3$	Hexagonal **C**—Rhombohedral, rare **M**—Granular, compact	Vitreous Dull Translucent to opaque	Yellowish Grayish brown Brown
FLUORITE (Fluor spar) CaF_2	Cubic **C**—Cubes, alone or modified, well developed **M**—Cleavable, granular, fibrous	Vitreous Transparent to nearly opaque	Wine yellow Yellowish brown Brown
ZEOLITES ***CHABAZITE** $CaAl_2Si_6O_{16}.8H_2O$, etc	Hexagonal **C**—Rhombohedral, cube-like, lenticular **M**—Compact	Vitreous Translucent to transparent	Yellowish Brownish
ZEOLITES ***Harmotome** $BaAl_2Si_6O_{16}.6H_2O$, etc.	Monoclinic **C**—Usually twins, penetrating at 90°	Vitreous Translucent	Yellowish Brownish
Xenotime YPO_4	Tetragonal **C**—Pyramidal, prismatic **M**—Compact, disseminated, rolled grains	Greasy Vitreous Translucent to opaque	Yellowish brown Reddish br Pale yellow

* Uncommon color.

Hardness 3 to 6

Hardness	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
3.5 4.	White Yellowish white	C—Pyramidal, indistinct F—Uneven Brittle	7. 7.3	Resembles pyromorphite, but not as common. With lead minerals—galena, pyromorphite.
3.5 4.5	White Gray	C—Rhombohedral, conspicuous F—Uneven Brittle	3.3 3.6	May turn brown to black on exposure due to MnO_2. With ore deposits. Associated with galena, sphalerite, pyrite, alabandite, psilomelane, silver minerals.
3.5 5.	White	C—Rhombohedral (crystals) F—Conchoidal, conspicuous Brittle to tough	2.9 3.1	Conchoidal fracture generally prominent. Compact varieties apparently very hard. In talcose and chloritic schists, serpentine, gypsum; independent deposits.
4.	White	C—Octahedral, perfect, conspicuous Brittle	3. 3.2	Recognized by crystal form, octahedral cleavage, and hardness. Common gangue of metallic ores, especially galena, sphalerite, cassiterite; also with calcite, barite.
4. 5.	White	C—Rhombohedral, not conspicuous F—Uneven Brittle	2.1 2.2	Generally in cube-like crystals. Inferior cleavage distinguishes it from fluorite and calcite. In basic igneous rocks. With analcite, stilbite, harmotome, laumontite, heulandite.
4. 5.	White	C—Pinacoidal F—Uneven Brittle	2.4 2.5	Cruciform twins. In basic igneous rocks and metalliferous veins. With chabazite, calcite, quartz, adularia. *Phillipsite*, contains calcium replacing barium.
4. 5.	Brownish white Yellowish white	C—Prismatic F—Uneven, splintery Brittle	4.4 4.6	Commonly as loose, disseminated, or attached crystals resembling zircon, but softer. In granite, gneiss, with zircon; also in alluvial deposits.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Scheelite $CaWO_4$	Tetragonal **C**—Pyramidal, small, more rarely tabular **M**—Drusy crusts, reniform, granular, compact	Greasy Adamantine Transparent to translucent	Pale yellow Yellowish brown Grayish bro
***Wollastonite** (Pyroxene, tabular spar) $CaSiO_3$	Monoclinic **C**—Tabular, prismatic **M**—Cleavable, fibrous, granular, compact	Vitreous Silky Transparent to translucent	Yellowish Brownish
APATITE $Ca_5F(PO_4)_3$	Hexagonal **C**—Prismatic, thick tabular, sometimes large, with rounded edges **M**—Compact, fibrous, nodular, reniform	Greasy Vitreous Translucent to opaque	Brown Greenish brown Reddish brown Yellow
HEMIMORPHITE (Calamine) $H_2Zn_2SiO_5$	Orthorhombic **C**—Thin tabular, pyramidal, hemimorphic, highly modified **M**—Compact, globular, granular, stalactitic, cellular, earthy	Vitreous Dull Transparent to translucent	Yellow Yellowish brown Brown
Huebnerite $MnWO_4$	Monoclinic **C**—Long fibrous, bladed, stalky; often divergent, without good terminations **M**—Compact, lamellar, granular	Resinous Submetallic Translucent to opaque	Reddish br Hair brown Pale yellow
SMITHSONITE $ZnCO_3$	Hexagonal **C**—Small, usually as druses or crusts **M**—Botryoidal, stalactitic, fibrous, compact, cellular, granular	Vitreous Dull Translucent to nearly opaque	Brown Yellowish brown Orange yellow

* Uncommon color.

Hardness 3 to 6

Hardness	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
4.5	White	**C**—Pyramidal, not conspicuous **F**—Conchoidal, uneven Brittle	5.9 6.2	Small, well developed octahedral-like crystals, usually on quartz; when massive high specific gravity important. With cassiterite, wolframite, fluorite, apatite, molybdenite.
4.5 **5.**	White	**C**—Basal, orthopinacoidal, perfect **F**—Uneven Brittle	2.8 2.9	Fibers may be parallel or divergent. Typical contact mineral; often in crystalline limestones. With garnet, diopside, vesuvianite, graphite.
4.5 **5.**	White	**C**—Basal, imperfect **F**—Conchoidal, uneven Brittle	3.1 3.2	Crystals may be vertically striated and have fused appearance. Color unevenly distributed, often with greenish spots. In crystalline limestones; metalliferous deposits; igneous rocks. With quartz, cassiterite, fluorite, wolframite.
4.5 **5.**	White	**C**—Prismatic **F**—Uneven, conchoidal Brittle	3.3 3.5	Crystals often in sheaf-like groups or druses in cavities. When massive, often porous or cellular. In limestones. With sphalerite, galena, and especially smithsonite.
4.5 **5.5**	Greenish gray	**C**—Clinopinacoidal, conspicuous Brittle	6.7 7.3	Structure, cleavage, and specific gravity characteristic. In quartz veins. With wolframite, fluorite, pyrite, scheelite, galena, tetrahedrite.
5.	White Gray	**C**—Rhombohedral, not often observed **F**—Uneven, splintery Brittle	4.1 4.5	Cellular varieties called *dry bone.* Often mixed with sand, clay, limonite, calcite. With zinc minerals, especially sphalerite, hemimorphite. Frequently pseudomorphous after calcite.

Streak—Uncolored, white, or light gray

	Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
ZEOLITES	**Natrolite** $Na_2Al(AlO)(SiO_3)_3.2H_2O$	Orthorhombic **C**—Slender prismatic, nearly square, radial or interlacing groups **M**—Fibrous, granular, compact	Vitreous Silky Transparent to translucent	Yellowish
ZEOLITES	**Thomsonite** $2(Ca,Na_2)Al_2(SiO_4)_2.-5H_2O$	Orthorhombic **C**—Prismatic, vertically striated, divergent groups **M**—Fibrous, columnar, radial; spherical concretions, compact	Vitreous Silky Pearly Translucent to transparent	Yellowish Brownish
	***Datolite** $Ca(B.OH)SiO_4$	Monoclinic **C**—Prismatic, pyramidal, highly modified **M**—Compact, fibrous, granular, botryoidal	Vitreous Greasy Dull Translucent to opaque	Yellow Brown
	TITANITE (Sphene) $CaTiSiO_5$	Monoclinic **C**—Wedge- or envelope-shaped when disseminated; tabular or prismatic when attached **M**—Compact, lamellar	Vitreous Greasy Transparent to opaque	Brown Reddish brown Yellow
	Monazite $(Ce,La,Di)PO_4$	Monoclinic **C**—Thick tabular, square prismatic **M**—Angular fragments, rolled grains	Greasy Vitreous Transparent to opaque	Reddish brown Yellowish brown Honey yel
	Cancrinite $H_6(Na_2,Ca)_4(NaCO_3)_2Al_3Si_9O_{36}$	Hexagonal **C**—Prismatic, rare **M**—Compact, lamellar, columnar, disseminated	Greasy Vitreous Pearly Translucent to transparent	Yellow Brownish yellow

* Uncommon color.

Hardness 3 to 6

ard-ess	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
5. 5.5	White	C—Prismatic, perfect F—Uneven Brittle	2.2 2.3	Crystals have nearly square cross-section. In basalts and phonolites. With chabazite, analcite, apophyllite, stilbite, prehnite, datolite.
5. 5.5	White	C—Pinacoidal F—Uneven Brittle	2.3 2.4	When massive, radial fibrous, often mottled or banded. In fissures and cavities in basic igneous rocks. With stilbite, analcite, prehnite, calcite.
5. 5.5	White	C—None F—Conchoidal, uneven Brittle	2.9 3.	Compact masses often with reddish, greenish, or whitish streaks and spots. In cracks and cavities in basic igneous rocks. With calcite, prehnite, epidote, native copper, zeolites.
5. 5.5	White Gray	C—Prismatic, conspicuous parting often noted F—Conchoidal Brittle	3.4 3.6	With feldspars, pyroxenes, amphiboles, chlorite, scapolite, zircon.
5. 5.5	White	C—Basal F—Conchoidal, uneven Brittle	4.9 5.3	Crystals commonly small, highly modified; rounded grains in sand. With quartz, magnetite, zircon, garnet, thorite, gold, chromite, diamond.
5. 6.	White	C—Prismatic F—Uneven Brittle	2.4 2.5	Easily recognized by associates—nephelite, sodalite, biotite, feldspar, titanite.

Streak—Uncolored, white, or light gray

	Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
	***NEPHELITE** (Nepheline, elæolite) $(Na,K)_8Al_8Si_9O_{34}$	Hexagonal **C**—Short prismatic, tabular **M**—Compact, disseminated grains	Greasy Vitreous Transparent to opaque	Yellowish Reddish br Brown
	ANTHOPHYLLITE (Amphibole) $(Mg, Fe)_4(SiO_3)_4$	Orthorhombic **C**—Prismatic, rare **M**—Lamellar, columnar, fibrous	Vitreous Pearly Translucent	Grayish br Yellowish brown Clove brow
PYROXENES	**ENSTATITE** $Mg_2(SiO_3)_2$	Orthorhombic **C**—Prismatic, rare **M**—Fibrous, lamellar, columnar, compact	Vitreous Pearly Translucent to opaque	Grayish br Greenish brown Yellowish
	Bronzite $(Mg,Fe)_2(SiO_3)_2$	Orthorhombic **C**—Prismatic, rare **M**—Fibrous, lamellar, compact	Bronzy Silky Translucent to opaque	Bronze brown Yellowish brown
	Hypersthene $(Fe,Mg)_2(SiO_3)_2$	Orthorhombic **C**—Prismatic, tabular, rare **M**—Granular, foliated, cleavable aggregates	Pearly Metalloidal Translucent to opaque	Dark brow Blackish brown
	***DIOPSIDE** $CaMg(SiO_3)_2$	Monoclinic **C**—Prismatic, thick columnar, prism angle 87° **M**—Compact, granular, columnar, lamellar	Vitreous Dull Transparent to opaque	Yellowish Brownish
	RHODONITE $MnSiO_3$	Triclinic **C**—Tabular, prismatic, rounded edges **M**—Compact, cleavable, granular, disseminated grains	Vitreous Dull Translucent to opaque	Yellowish Brownish

* Uncommon color.

Hardness 3 to 6

ard-ness	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
5. 6.	White	C—Indistinct F—Conchoidal, uneven Brittle	2.6	Distinguished from orthoclase by inferior cleavage and more greasy luster. With feldspars, cancrinite, biotite, sodalite, corundum; not with quartz.
5. 6.	White Grayish	C—Prismatic F—Fibrous Brittle	3.1 3.2	Often with metallic schiller, resembling bronzite and hypersthene. Softer when altered. In crystalline schists. With talc, hornblende, mica.
5. 6.	White Grayish	C—Prismatic, pinacoidal, conspicuous F—Uneven Brittle	3.1 3.3	Often softer due to alteration to serpentine. Commonly in basic igneous rocks. With olivine, chondrodite, serpentine, talc.
5. 6.	White Grayish	C—Prismatic, pinacoidal, conspicuous F—Uneven Brittle	3.2 3.5	Cleavage surfaces usually fibrous or lamellar, irregular or wavy, with distinct bronzy luster; darker than enstatite. In basic igneous rocks.
5. 6.	White Grayish	C—Pinacoidal, conspicuous F—Uneven Brittle	3.3 3.5	Copper red iridescence often noted, due to small, tabular inclusions. In the more basic igneous rocks. With feldspar (labradorite), olivine, hornblende, pyrrhotite, magnetite.
5. 6.	White Gray	C—Prismatic; conspicuous basal parting F—Uneven Brittle	3.2 3.3	Crystals prismatic, pseudotetragonal, with distinct basal parting. In crystalline limestones. Commonly with vesuvianite, garnet, scapolite, spinel, apatite.
5. 6.	White	C—Prismatic, basal F—Conchoidal, uneven Crystals brittle, tough when massive	3.4 3.7	Due to exposure may be stained brown or black. *Fowlerite*, contains zinc. With franklinite, zincite, willemite, calcite, iron ores.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Willemite (Troostite) Zn_2SiO_4	Hexagonal **C**—Prismatic **M**—Compact, granular, disseminated grains	Greasy Vitreous Transparent to opaque	Yellow Greenish yellow Brown
OPAL, varieties *Precious opal* $SiO_2.nH_2O$ *Wood opal* *Opal jasper* *Silicious sinter* *Tripolite*	Amorphous **M**—Compact, reniform, botryoidal, porous, earthy	Vitreous Greasy Dull Translucent to opaque	Yellow Yellowish brown Brown
***Orthite** (Allanite) $Ca_2(Al,Ce,Fe)_2(Al.OH)(SiO_4)_3$	Monoclinic **C**—Tabular, rare **M**—Compact, granular, bladed, disseminated grains	Greasy Submetallic Translucent to opaque	Dark brow Blackish brown Yellowish brown
Anatase (Octahedrite) TiO_2	Tetragonal **C**—Pyramidal, tabular, rarely prismatic	Adamantine Metallic Translucent to semi-opaque	Reddish br Yellowish brown Dark brow
Brookite TiO_2	Orthorhombic Only in crystals,—pyramidal (often with hexagonal habit), prismatic, tabular	Adamantine Metallic Opaque	Dark brow Reddish br
Perovskite $CaTiO_3$	Pseudocubic **C**—Apparently cubes, highly modified, often striated **M**—Reniform aggregates, rounded grains	Adamantine Submetallic Transparent to translucent	Pale yello Orange ye Reddish br
***Amblygonite** $Li(AlF)PO_4$	Triclinic **C**—Rare **M**—Cleavable, columnar, compact	Pearly Vitreous Translucent	Yellowish Brownish

* Uncommon color.

Hardness 3 to 6

ard- ess	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
5. 6.	White	C—Basal, prismatic F—Uneven Brittle	3.9 4.3	Crystals of willemite small, of troostite, manganiferous variety, often large. Characterized by associates—franklinite, zincite, rhodonite, calcite.
5.5 6.	White	F—Conchoidal, conspicuous when compact; earthy Brittle	2.1 2.3	*Precious opal*, play of colors; *wood opal*, woody structure; *opal jasper*, greasy, resembling jasper; *silicious sinter*, porous; *tripolite*, earthy and gritty.
5.5 6.	Gray Greenish gray Brownish gray	C—Pinacoidal, indistinct F—Uneven, conchoidal Brittle	3. 4.	Often covered with brownish or yellowish alteration product. In the more acid igneous rocks; also in limestone. With epidote, quartz, feldspar.
5.5 6.	White Gray	C—Pyramidal, basal F—Subconchoidal Brittle	3.8 3.9	Crystals often resemble elongated octahedrons. With brookite, rutile, ilmenite, adularia, titanite, gold.
5.5 6.	Gray Yellowish white Brownish white	C—Indistinct F—Uneven Brittle	3.8 4.1	Crystals may be striated; not twinned like rutile. With rutile, anatase, titanite, adularia, nephelite.
5.5 6.	White Grayish	C—Cubical, indistinct F—Uneven Brittle	4. 4.1	With chlorite, magnetite, limestone, serpentine.
6.	White	C—Basal, perfect, conspicuous; macropinacoidal, domatic F—Uneven Brittle	3. 3.1	Usually in cleavable masses, showing excellent cleavage in one direction. Resembles orthoclase. With lepidolite, rubellite, wavellite, petalite.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
ORTHOCLASE (Feldspar) $KAlSi_3O_8$	Monoclinic **C**—Prismatic, thick tabular; twins; often large **M**—Cleavable, granular, disseminated	Vitreous Pearly Transparent to opaque	Pale yellow Brownish yellow
Chondrodite $[Mg(F,OH)]_2Mg_3(SiO_4)_2$	Monoclinic **C**—Small, highly modified, rare **M**—Rounded, disseminated grains, compact	Vitreous Greasy Translucent to opaque	Reddish br Yellowish brown Honey ye
Zoisite $Ca_2Al_2(Al.OH)(SiO_4)_3$	Orthorhombic **C**—Prismatic, deeply striated, bent, without good terminations **M**—Columnar, broad bladed, fibrous	Vitreous Translucent to opaque	Brown Yellowish brown Yellow
Sillimanite (Fibrolite) Al_2SiO_5	Orthorhombic **C**—Long, thin, needle-like **M**—Fibrous, columnar, radiating	Vitreous Silky Transparent to translucent	Hair brow Grayish br
Axinite $M_7''M_4'''B_2(SiO_4)_8$ $M'' = Ca,Fe,Mn,Mg$ $M''' = Al,Fe$	Triclinic **C**—Broad tabular, with sharp edges **M**—Lamellar, granular	Vitreous Transparent to translucent	Clove bro Honey ye Greenish yellow
EPIDOTE $Ca_2(Al,Fe)_2(Al.OH)(SiO_4)_3$	Monoclinic **C**—Prismatic, elongated and deeply striated parallel to *b* axis; usually terminated on one end only **M**—Columnar; fibrous, parallel and divergent; granular	Vitreous Transparent to opaque	Greenish brown Greenish yellow Yellow

Hardness over 6

Hardness	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
6. 6.5	White	C—Basal, clinopinacoidal, conspicuous —90° F—Conchoidal, uneven Brittle	2.5 2.6	Characterized by rectangular cleavages and absence of twinning striations. In granitic rocks. With quartz, other feldspars, mica, hornblende.
6. 6.5	White	C—Basal, indistinct F—Conchoidal, uneven Brittle	3.1 3.3	Associates important. In crystalline limestones and dolomites. With spinel, vesuvianite, pyroxenes, mica.
6. 6.5	White	C—Brachypinacoidal, conspicuous F—Uneven Brittle	3.3 3.4	Deeply furrowed and transversely broken columnar masses. In crystalline schists. With hornblende, vesuvianite, quartz, epidote, garnet, feldspar.
6. 7.	White	C—Macropinacoidal F—Uneven Brittle	3.2 3.3	Crystals often slender, bent, striated, with rounded edges, without good terminations, and interlaced. In metamorphic rocks—mica schist, gneiss. With andalusite, garnet, iolite.
6. 7.	White	C—Pinacoidal F—Conchoidal Brittle	3.3	Crystals, sharp wedge-shaped, glassy; frequently coated and intergrown with green chlorite. With quartz, adularia, albite, hornblende.
6. 7.	White Grayish	C—Basal F—Uneven Brittle	3.3 3.5	Crystals often darker than when massive. With quartz, feldspar, vesuvianite, hornblende, pyroxenes, magnetite, prehnite, native copper.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Diaspore AlO.OH	Orthorhombic **C**—Broad columnar, tabular, rare **M**—Scaly, confused fibrous, bladed aggregates	Vitreous Pearly Transparent to translucent	Pale yellow Brown
RUTILE TiO_2 or $TiTiO_4$	Tetragonal **C**—Prismatic, vertically striated; twinned, yielding knee-shaped or rosette forms **M**—Compact, disseminated	Adamantine Submetallic Translucent to opaque	Reddish bro Yellowish brown Dark brow
***Gadolinite** $Fe[Be(Y.O)SiO_4]_2$	Monoclinic **C**—Prismatic, rare **M**—Compact, disseminated	Vitreous Greasy Translucent to opaque	Brown
CASSITERITE SnO_2 or $SnSnO_4$	Tetragonal **C**—Thick prismatic; knee-shaped twins quite common **M**—Reniform, botryoidal, compact, rounded pebbles, often with internal radial, fibrous structure, *wood tin*	Adamantine Greasy Dull Translucent to opaque	Reddish brown Yellowish brown Dark brow
ANDALUSITE Al_2SiO_5	Orthorhombic **C**—Prismatic, rough, nearly square, often large, without terminations **M**—Columnar, fibrous, granular, disseminated	Vitreous Dull Translucent to opaque	Reddish brown Brown

* Uncommon color.

Hardness over 6

Hardness	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
6. 7.	White	C—Brachypinacoidal, conspicuous F—Conchoidal Brittle	3.3 3.5	Yellow and brown colors usually due to limonite coating. With corundum, emery, dolomite, margarite, chlorite, magnetite.
6. 7.	Gray Yellowish white Brownish white	C—Prismatic, pyramidal, not conspicuous F—Uneven Brittle	4.2 4.3	Not as heavy as cassiterite. Often in fine hair-like inclusions. With quartz, feldspar, hematite, ilmenite, chlorite, brookite.
6. 7.	Greenish gray	C—None F—Conchoidal splintery Brittle	4. 4.5	In granitic rocks and pegmatites. With fergusonite, orthite, fluorite, molybdenite.
6. 7.	White Yellowish white Brownish white	C—Indistinct F—Uneven Brittle	6.8 7.	Distinguished by high specific gravity. In veins cutting granite, gneiss; in alluvial deposits as *stream tin*. With quartz, wolframite, scheelite, molybdenite, tourmaline, fluorite, mica, chlorite.
6. 7.5	White	C—Prismatic F—Uneven Brittle	3.1 3.2	Due to alteration, surface may be covered with scales of mica, hence, softer. In metamorphic rocks often as rounded or knotty projections. With cyanite, sillimanite, garnet, tourmaline.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
VESUVIANITE $Ca_6[Al(OH,F)]Al_2(SiO_4)_5$	Tetragonal **C**—Short prismatic **M**—Compact, granular; aggregates with parallel or divergent striations or furrows	Vitreous Greasy Translucent to opaque	Brown Greenish brown Sulphur yellow
***OLIVINE** $(Mg,Fe)_2SiO_4$	Orthorhombic **C**—Prismatic, thick tabular **M**—Rounded, disseminated grains; granular aggregates	Vitreous Transparent to translucent	Reddish brown Yellowish brown
GARNET, varieties *Grossularite* $M_3''M_2'''(SiO_4)_3$ *Spessartite* $M'' = Ca,Fe,Mg$ *Almandite* $M''' = Al,Fe$ *Andradite*	Cubic **C**—Dodecahedrons, tetragonal trisoctahedrons, alone or in combination **M**—Granular, compact, lamellar, disseminated grains, sand	Vitreous Transparent to opaque	Yellow Cinnamon brown Reddish brown
QUARTZ, Crystalline varieties *Smoky quartz* SiO_2 *False topaz* *Aventurine* *Ferruginous* *Cat's eye*	Hexagonal **C**—Prismatic, horizontally striated **M**—Compact, granular	Vitreous Greasy Transparent to opaque	Yellow Yellowish brown Smoky bro Reddish brown
Cryptocrystalline varieties *Chalcedony* *Agate* *Jasper* *Flint*	Hexagonal **C**—Never in crystals **M**—Nodular, botryoidal, banded, concretionary, stalactitic, compact	Waxy Vitreous Translucent to opaque	Yellow Brown Blackish brown

* Uncommon color.

Hardness over 6

Hardness	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
6.5	White	**C**—Indistinct **F**—Uneven Brittle	3.3 3.5	In crystalline limestone, gneiss, schist. With garnet, tourmaline, chondrodite, wollastonite, epidote, pyroxenes.
6.5 **7.**	White Yellowish white Brownish white	**C**—Pinacoidal, indistinct **F**—Conchoidal Brittle	3.2 3.6	In basic igneous rocks—basalt, traps; crystalline limestone. With augite, magnetite, spinel, chromite, pyrope, plagioclase.
6.5 **7.5**	White	**C**—Dodecahedral, usually indistinct **F**—Conchoidal, uneven Brittle	3.4 4.3	*Grossularite*, in crystalline limestone, dolomite, with wollastonite, vesuvianite, diopside, scapolite; *spessartite*, in granitic rocks, with quartz, tourmaline, orthoclase; *almandite*, with mica, staurolite, andalusite, cyanite; *andradite*, with epidote, feldspar, nephelite, leucite.
7.	White Yellowish white Brownish white	**C**—Indistinct **F**—Conchoidal, conspicuous Brittle	2.6	Characteristic conchoidal fracture and glassy luster. *Smoky quartz*, smoky yellow to brownish black; *false topaz*, yellow; *aventurine*, glistening with included scales; *ferruginous*, colored by iron oxide, *cat's eye*, opalescent, due to inclusions of fibers of asbestos.
7.	White Yellowish white Brownish white	**C**—Indistinct **F**—Conchoidal, conspicuous Brittle to tough	2.6	Not as glassy as crystalline varieties. *Chalcedony*, pale to dark brown, waxy luster; *agate*, banded or clouded; *jasper*, commonly yellow and uniform in color; *flint*, smoky or blackish brown, nodular, often with white coating.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
QUARTZ, Clastic varieties *Sand* SiO_2 *Sandstone* *Quartzite*	Hexagonal **M**—Grains, fragments, either loose or strongly consolidated	Vitreous Dull Translucent to opaque	Yellow Yellowish brown Brown
***Boracite** $Mg_7Cl_2B_{16}O_{30}$	Pseudocubic **C**—Tetrahedral, cubical, small, well developed **M**—Compact, nodular, fine fibrous	Vitreous Transparent to opaque	Yellow Grayish yellow Brownish
Danburite $CaB_2(SiO_4)_2$	Orthorhombic **C**—Prismatic, highly modified **M**—Disseminated	Vitreous Greasy Transparent to translucent	Wine yellow Honey yello Dark brown
TOURMALINE $M'_{20}B_2Si_4O_{21}$ M′ = Na,K,Li,Mg, Ca,(OH),Fe,Al	Hexagonal **C**—Prismatic, vertically striated; terminated with broken or rhombohedral-like surfaces **M**—Compact, granular	Vitreous Translucent to opaque	Brown Yellowish brown Yellow
STAUROLITE $Fe(AlO)_4(Al.OH)(SiO_4)_2$	Orthorhombic **C**—Prismatic; twins plus- (+) or X-shaped; well developed	Vitreous Dull Translucent to opaque	Reddish brown Yellowish brown Blackish brown
Phenacite Be_2SiO_4	Hexagonal **C**—Rhombohedral, pyramidal, lenticular, highly modified	Vitreous Transparent to translucent	Wine yellow Brown
ZIRCON $ZrSiO_4$	Tetragonal **C**—Square prisms and bipyramids, small, well developed **M**—Irregular lumps, grains	Adamantine Vitreous Greasy Transparent to opaque	Reddish brown Dark brown Brownish yellow

* Uncommon color.

Hardness over 6

ard-ess	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
7.	White Yellowish white Brownish white	C—Indistinct F—Uneven Brittle to tough	2.6	Pigment is usually ferruginous matter. *Sand*, loose, unconsolidated grains; *sandstone*, consolidated sand; *quartzite*, metamorphosed sandstone.
7.	White	C—None F—Conchoidal, uneven Brittle	2.9 3.	Disseminated, glassy crystals common; compact masses resemble fine grained marble. With gypsum, anhydrite, halite, carnallite.
7. 7.5	White	C—Indistinct F—Uneven conchoidal Brittle	2.9 3.	Resembles topaz, but cleavage not as perfect. With calcite, dolomite, mica, microcline, pyroxene, tourmaline.
7. 7.5	White	C—None F—Conchoidal, uneven Brittle	2.9 3.2	Spherical, triangular cross-section. Commonly as contact mineral in granular limestone and dolomite. With tremolite, scapolite, vesuvianite, apatite, garnet, spinel.
7. 7.5	White Grayish	C—Brachypinacoidal F—Conchoidal, uneven Brittle	3.4 3.8	Fresh crystals usually possess bright, smooth faces, when altered dull, rough, softer and with colored streak. In metamorphic rocks—gneiss, mica schist, slate. With cyanite, garnet, tourmaline, sillimanite
7. 8.	White	C—Indistinct F—Conchoidal Brittle	3.	Distinguished from quartz and topaz by crystal form and cleavage. In pegmatites and metamorphic rocks. With quartz, topaz, beryl, amazonstone, chrysoberyl.
7.5	White	C—Indistinct F—Uneven Brittle	4.4 4.8	In the more acid igneous rocks—granite, syenite; alluvial deposits, with gold, spinel, corundum, garnet. *Hyacinth*, clear and transparent.

Streak—Uncolored, white, or light gray

Name Composition		Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
BERYL $Be_3Al_2(SiO_3)_6$		Hexagonal **C**—Long prismatic, often vertically striated, large **M**—Columnar, granular, compact	Vitreous Transparent to translucent	Pale yellow Honey yell Brownish yellow
SPINEL, varieties $M''(M'''O_2)_2$ $M'' = Mg,Fe,Zn$ $M''' = Al,Fe$	*Pleonaste* *Gahnite*	Cubic **C**—Octahedral, well developed **M**—Compact, granular, disseminated grains	Vitreous Dull Nearly opaque	Yellow Grayish brown Brown
TOPAZ $Al_2(F,OH)_2SiO_4$		Orthorhombic **C**—Prismatic, vertically striated, highly modified **M**—Compact, granular, rolled fragments	Vitreous Transparent to opaque	Straw yell Wine yello Yellowish brown
Chrysoberyl $Be(AlO_2)_2$		Orthorhombic **C**—Tabular; heart-shaped, pseudohexagonal twins **M**—Fragments, loose, rounded grains	Vitreous Greasy Transparent to translucent	Yellow Greenish yellow Brown
CORUNDUM, varieties Al_2O_3	*Oriental topaz* *Common*	Hexagonal **C**—Prismatic, tabular, pyramidal, rhombohedral; rough or rounded barrel-shaped **M**—Compact, granular, lamellar	Vitreous Translucent to transparent	Yellow Brown

Hardness over 6

ard-ess	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
7.5 8.	White	C—Basal, indistinct F—Conchoidal, uneven Brittle	2.6 2.8	Crystals usually simple, prism and base. In granitic rocks, mica schists, clay slates. With quartz, feldspar, mica, chrysoberyl, topaz, cassiterite, garnet.
7.5 8.	White Grayish	C—Indistinct F—Conchoidal Brittle	3.6 4.4	Commonly as contact mineral in granular limestone; in more basic igneous rocks; as rounded grains in placers. With calcite, chondrodite, serpentine, brucite, graphite, pyroxenes.
8.	White	C—Basal, perfect, conspicuous F—Conchoidal, uneven Brittle	3.4 3.6	Crystals usually developed on one end only. Color may fade on exposure. Massive varieties distinguished from quartz by higher specific gravity and basal cleavage. In veins and cavities in granitic rocks, also in placers. With cassiterite, tourmaline, fluorite, apatite, beryl, wolframite.
8.5	White	C—Brachypinacoidal F—Uneven, conchoidal Brittle	3.5 3.8	Crystals disseminated as plates, often with feather-like or radial striations. In granite, gneiss, placers. With beryl, garnet, tourmaline, sillimanite.
9.	White	C—None, nearly rectangular basal and rhombohedral partings, conspicuous; often striated F—Conchoidal Brittle to tough	3.9 4.1	When massive often multicolored—red, blue, green, gray. *Oriental topaz,* transparent, yellow. In limestone, granite, syenite, alluvial deposits. With magnetite, nephelite, mica, spinel, chlorite.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Ulexite $NaCaB_5O_9.6H_2O$	Monoclinic **C**—Acicular, capillary **M**—Fine fibrous interwoven, ball-like aggregates	Silky Pearly Translucent	White Snow white
Natron (Soda) $Na_2CO_3.10H_2O$	Monoclinic **M**—Crystalline crusts, earthy efflorescences	Vitreous Earthy Transparent to translucent	Colorless Gray Yellowish white
Cerargyrite (Horn silver) AgCl	Cubic **C**—Rare **M**—Wax-like crusts, coatings; stalactitic, dendritic	Waxy Greasy Transparent to translucent	Pearl gray Grayish
Carnallite $MgCl_2.KCl.6H_2O$	Orthorhombic **C**—Pseudohexagonal, rare **M**—Compact, granular	Vitreous Dull Transparent to translucent	Milk white Gray Colorless
Calomel HgCl	Tetragonal **C**—Small, tabular pyramidal **M**—Coatings	Adamantine Translucent to nearly opaque	White Grayish Yellowish white
Asbestos, variety *Chrysotile* $H_4Mg_3Si_2O_9$	Orthorhombic ? **M**—Coarse or fine fibrous, felted	Silky Silky metallic Opaque	White Greenish white Yellowish white
variety *Amphibole* Silicate of Ca, Mg, Fe, Al, etc.	Monoclinic ? **M**—Coarse or fine fibrous, felted; compact, leather- or cork-like	Silky Dull Opaque	White Greenish white Yellowish white
TRIPOLITE (Opal) $SiO_2.nH_2O$	Amorphous **M**—Porous, earthy, chalk-like	Dull Opaque	Gray White Yellowish white

Hardness 1 to 3

ırd- ess	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
. .	White	F—Fibrous Brittle	1.6 1.8	Tasteless. Soft, fibrous, rounded masses with loose texture, apparently very light. Easily pulverized between fingers. With halite, gypsum, glauberite, borax.
.. ..5	White	F—Conchoidal Brittle	1.4 1.5	Natural crystals unknown. Taste alkaline. Loses water on exposure to air. Principally in soda lakes. With halite, trona, thermonatrite.
1. 1.5	White, shiny Gray, shiny	C—None F—Conchoidal Highly sectile	5.5 5.6	Cuts like wax, yielding shiny surfaces; on exposure turns violet, brown, or black. With silver minerals, especially argentite, native silver; also limonite, calcite, barite.
.. 2.	White	C—Indistinct F—Conchoidal Brittle	1.6	Bitter taste; absorbs moisture. With halite, kieserite, sylvite, anhydrite, boracite.
.. 2.	White Gray	C—Indistinct F—Conchoidal Very sectile	6.4 6.5	Characterized by high specific gravity and associates, especially cinnabar, native mercury; also barite, tetrahedrite.
.. 2.5	White	F—Fibrous Flexible	1. 2.5	*Short fibered asbestos,* delicate, fine, parallel, flexible fibers, easily separable, perpendicular to walls. Compare below. In veins or seams in compact serpentine.
.. 2.5	White	F—Fibrous Flexible, tough	1. 2.5	*Long fibered asbestos,* parallel, flexible fibers, parallel to walls. Compare above. *Mountain leather, mountain cork, mountain wood,* compact, but light and tough.
1.. 2.5	White	F—Earthy Friable	2.1 2.3	Apparently very soft, but fine particles scratch glass. Resembles chalk and kaolinite, but gritty, and not plastic when moistened. Due to impurities may have clay odor.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
KAOLINITE (Kaolin, china clay) $H_4Al_2Si_2O_9$	Monoclinic **C**—Scaly, rare **M**—Compact, friable, mealy, clay-like	Dull Pearly Opaque to translucent	White Gray Colorless
CALCITE, varieties *Chalk* $CaCO_3$ *Marl*	Hexagonal **M**—Loose or compact, earthy	Earthy Dull Opaque	White Grayish Yellowish white
TALC, varieties *Foliated* $H_2Mg_3Si_4O_{12}$ *Soapstone or steatite* *French chalk*	Monoclinic **C**—Thin tabular, indistinct **M**—Foliated, globular, fibrous, granular, compact	Pearly Greasy Transparent to opaque	White Greenish w Gray
Pyrophyllite $H_2Al_2Si_4O_{12}$	Orthorhombic ? **C**—Indistinct **M**—Radiated, fibrous, lamellar aggregates; granular, compact	Pearly Greasy Dull Translucent to opaque	White Greenish w Gray
BAUXITE $Al_2O(OH)_4$	Never in crystals **M**—Pisolitic, oolitic, rounded disseminated grains; clay-like, earthy	Dull Earthy Opaque	White Grayish
Mirabilite (Glauber salt) $Na_2SO_4.10H_2O$	Monoclinic **C**—Rare **M**—Mealy efflorescences, fibrous crusts	Vitreous Transparent to opaque	Colorless White Yellowish white
SAL AMMONIAC NH_4Cl	Cubic **C**—Distorted, rare **M**—Fibrous, powdery, stalactitic, crusts	Vitreous Transparent to translucent	Colorless White Grayish

Hardness 1 to 3

ard-ess	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
1. 2.5	White	C—Basal (scales) F—Earthy Brittle	2.2 2.6	Not gritty like tripolite. Very strong clay odor when breathed upon. Usually adheres to tongue and becomes plastic when moistened. Greasy feel. With quartz, feldspar, corundum, diaspore.
1. 2.5	White	C—None F—Earthy Brittle	2.7	*Chalk*, earthy masses; *marl*, more clay-like and frequently contains organic material—leaves, twigs. In extensive deposits.
1. 2.5	White	C—Basal, conspicuous, when foliated F—Uneven, splintery Sectile, laminæ flexible	2.6 2.8	Greasy or soapy feel important. *Foliated talc*, easily separable, inelastic folia or plates, H = 1; *soapstone* or *steatite*, coarse to fine granular, rather impure, H = 1.5—2.5; *French chalk*, soft, compact, marks cloth distinctly. With serpentine, dolomite, chlorite, magnesite, actinolite.
1. 2.5	White	C—Longitudinal F—Fibrous, uneven minæ flexible	2.8 2.9	Soft and greasy like talc, but usually in radiating fibers. In schistose rocks. With cyanite, lazulite, graphite.
1. 3.	White	F—Earthy Brittle	2.5	Clay odor when breathed upon. Usually distinguished from clay by pisolitic or oolitic structure. With clay or kaolin in nodules, grains, or irregular masses in limestone or dolomite.
1.5 2.	White	C—Orthopinacoidal F—Conchoidal Brittle	1.4 1.5	Taste, cool, then slightly salty and bitter. On exposure loses water, turns white, and crumbles. With halite, gypsum, clay, marl.
1.5 2.	White	C—Indistinct F—Conchoidal Brittle	1.5	Pungent, salty taste, somewhat astringent. Usually sublimation product. Near volcanoes, burning coal beds, guano deposits.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Struvite $NH_4MgPO_4.6H_2O$	Orthorhombic **C**—Domatic, hemimorphic **M**—Granular, earthy	Vitreous Dull Translucent to opaque	Gray White Colorless
Niter (Saltpeter) KNO_3	Orthorhombic **C**—Pseudohexagonal, rare **M**—Crusts, fine needle-like aggregates; efflorescences	Vitreous Translucent	Colorless White Gray
SODA NITER (Chile saltpeter) $NaNO_3$	Hexagonal **C**—Similar to those of calcite, rare **M**—Granular, crusts, efflorescences	Vitreous Transparent	Colorless White Grayish
GYPSUM, varieties $CaSO_4.2H_2O$ *Selenite* *Satin spar* *Alabaster* *Common*	Monoclinic **C**—Tabular, prismatic; swallow-tail twins **M**—Cleavable, coarse or fine grained, fibrous, foliated, earthy	Pearly Vitreous Silky Dull Transparent to opaque	Colorless White Gray
***Vivianite** $Fe_3(PO_4)_2.8H_2O$	Monoclinic **C**—Prismatic, tabular **M**—Reniform, globular, with radial fibrous structure; earthy	Vitreous Dull Transparent to opaque	Colorless Bluish wh Greenish v
Copiapite (Misy) $Fe_2(Fe.OH)_2(SO_4)_5.18H_2O$	Monoclinic **C**—Tabular, six-sided **M**—Granular, scales, powder	Pearly Dull Translucent	White Yellowish white
Melanterite (Copperas) $FeSO_4.7H_2O$	Monoclinic **C**—Rare **M**—Capillary, fibrous, stalactitic, concretionary, powder	Vitreous Dull Transparent to translucent	White Greenish v Yellowish white

* Uncommon color.

Hardness 1 to 3

ard- ness	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
1.5 2.	White	C—Pinacoidal, perfect F—Conchoidal Brittle	1.7	Crystals coffin-shaped, with pronounced hemimorphism. In sewers, vaults, guano deposits.
1.5 2.	White	C—Indistinct F—Conchoidal Brittle	1.9 2.1	Cooling and saline taste. Does not absorb moisture. As an efflorescence; in limestone caves. Never in extensive deposits like soda niter.
1.5 2.	White	C—Rhombohedral F—Conchoidal Brittle	2.1 2.3	Cooling and saline taste. Absorbs moisture readily. In extensive deposits. With gypsum, sand, clay, guano.
1.5 2.	White	C—Clinopinacoidal, conspicuous; pyramidal, orthopinacoidal F—Conchoidal, fibrous Brittle, laminæ flexible	2.2 2.4	*Selenite*, crystals and cleavage plates, usually transparent; *satin spar*, fibrous with silky luster; *alabaster*, granular. In limestones, shales. With halite, celestite, sulphur, aragonite, dolomite; ore deposits.
1.5 2.	White Bluish white	C—Clinopinacoidal F—Fibrous, earthy Sectile, thin laminæ flexible	2.6 2.7	On exposure color and streak change rapidly to blue. In clay, peat, bones, shells. With limonite, pyrrhotite, pyrite.
1.5 2.5	White Yellowish white	C—Pinacoidal F—Earthy, scaly Brittle	2.1	Disagreeable metallic taste. Oxidation product of iron sulphide minerals—pyrite, marcasite, pyrrhotite.
2.	White	C—Basal F—Conchoidal, earthy Brittle	1.8 1.9	On exposure loses water and crumbles. Sweet, astringent taste, somewhat metallic. Oxidation product of iron sulphide minerals—marcasite, pyrite, chalcopyrite, pyrrhotite.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Sepiolite (Meerschaum) $H_4Mg_2Si_3O_{10}$	Monoclinic ? **M**—Compact, nodular with smooth feel; earthy, clay-like	Dull Opaque	White Grayish w
Borax (Tinkal) $Na_2B_4O_7.10H_2O$	Monoclinic **C**—Short columnar **M**—Compact, earthy	Vitreous Greasy Dull Translucent to opaque	Colorless White Grayish
Epsomite (Epsom salt) $MgSO_4.7H_2O$	Orthorhombic **C**—Prismatic, nearly square, rare **M**—Granular, fibrous, earthy, crusts	Vitreous Dull Transparent to translucent	White Colorless Gray
Sylvite KCl	Cubic **C**—Cubes, alone or with octahedron **M**—Compact, granular	Vitreous Transparent to translucent	Colorless White Grayish
HALITE (Rock salt) NaCl	Cubic **C**—Cubes, often skeletal or hopper-shaped **M**—Compact, cleavable, granular, fibrous, stalactitic, crusts	Vitreous Transparent to translucent	Colorless White Grayish
Brucite $Mg(OH)_2$	Hexagonal **C**—Broad tabular **M**—Foliated, scaly, fibrous	Pearly Vitreous Transparent to translucent	Colorless White Greenish white
Pharmacolite $CaHAsO_4.2H_2O$	Monoclinic **C**—Rare **M**—Fibrous, botryoidal, crusts, powder	Vitreous Pearly Translucent to opaque	White Grayish

Hardness 1 to 3

ard-ess	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
2. 2.5	White	C—None F—Conchoidal, uneven Brittle	1. 2.	Recognized by smooth feel, adherence to tongue, low specific gravity and lack of clay odor when breathed upon. Impressed by finger nail. With serpentine, magnesite, chlorite.
2. 2.5	White	C—Indistinct F—Conchoidal Brittle	1.7 1.8	Usually coated with white powdery crust. Feebly alkaline taste. In muds of alkaline lakes. With halite, natron.
2. 2.5	White	C—Brachypinacoidal F—Conchoidal Brittle	1.7 1.8	Non-hygroscopic. Bitter, salty taste. In limestone caves. With serpentine, talc, magnesite.
2. 2.5	White	C—Cubic F—Conchoidal Brittle	1.9 2.	Salty bitter taste. May absorb moisture and become damp. In salt deposits. With halite, kainite, carnallite.
2. 2.5	White	C—Cubic, perfect, conspicuous F—Conchoidal Brittle	2.1 2.3	May absorb moisture and become damp. Characteristic cubical cleavage and saline taste. With slate, gypsum, anhydrite, polyhalite.
2. 2.5	White	C—Basal, perfect, conspicuous Thin plates or scales, flexible	2.3 2.4	Distinguished from selenite (gypsum) by more pearly luster, slightly greater hardness, and crystal form; from muscovite by non-elasticity of plates or scales; foliated talc is softer with greasy feel. With serpentine, limestone.
. .5	White	C—Clinopinacoidal, rarely observed F—Uneven Sectile, thin laminæ flexible	2.6 2.7	May be reddish or greenish due to admixture of erythrite or annabergite. Commonly as powder or stain on arsenic minerals.

Streak—Uncolored, white, or light gray

	Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
	SENARMONTITE Sb_2O_3	Cubic **C**—Octahedral **M**—Granular, crusts	Greasy Pearly Transparent to translucent	Colorless White Gray
MICAS	**Lepidolite** $(Li,H)_2(F.OH)_2Al_2Si_3O_9$	Monoclinic **C**—Short prismatic **M**—Coarse or fine granular, scales, cleavable plates	Pearly Translucent	White Pinkish wh Lavender Gray
MICAS	PARAGONITE $H_2NaAl_3(SiO_4)_3$	Monoclinic **M**—Compact, fine scaly aggregates	Pearly Translucent	Grayish Yellowish white Greenish white
MICAS	**MUSCOVITE** (Isinglass) $H_2KAl_3(SiO_4)_3$	Monoclinic **C**—Tabular, pyramidal, with orthorhombic or hexagonal outline; often large and rough **M**—Scales, plates; foliated and plumose aggregates.	Vitreous Pearly Transparent to translucent	Colorless Yellowish white Brownish white
	APATITE, variety *Phosphate rock* Mainly calcium carbonate—phosphate (collophane)	Amorphous **M**—Compact, fibrous, nodular, reniform, earthy	Dull Opaque	White Gray
	GRÜNERITE (Amphibole) $H_2Fe_7(SiO_3)_8$	Monoclinic **C**—Fine acicular **M**—Fibrous, lamellar	Silky Translucent to opaque	Gray Greenish g
	Glauberite $Na_2SO_4.CaSO_4$	Monoclinic **C**—Thick tabular **M**—Reniform, lamellar	Vitreous Greasy Transparent to translucent	Colorless White Gray

Hardness 1 to 3

ard-ess	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
2. 2.5	White	C—Octahedral, indistinct F—Uneven Brittle	5.2 5.3	Pearl colored octahedrons. With ores of antimony—stibnite, kermesite, native antimony.
2. 3.	White	C—Basal, perfect F—Scaly granular Tough	2.8 2.9	When massive often resembles granular limestone. In pegmatites, granites, gneisses. With red tourmaline (rubellite), amblygonite, spodumene, cassiterite.
2. 3.	White	C—Basal, perfect F—Scaly, granular Tough	2.8 2.9	Distinguished from other micas by associates—cyanite, staurolite, tourmaline.
2. 3.	White	C—Basal, perfect, conspicuous Tough, laminæ very elastic	2.8 3.1	Structure, perfect cleavage, and elasticity important. Large crystals often show distinct partings perpendicular to cleavage, *ruled mica*. In granitic rocks, schists, limestones. With feldspar, quartz, beryl, tourmaline, garnet, spodumene.
2. 3.	White	F—Conchoidal, uneven Brittle	3.1 3.2	More or less impure masses, frequently resembling compact limestone. Independent beds, nodules, concretions.
3. 3.	White	C—Fibrous Brittle	3.7	Usually with quartz, magnetite, and known as *magnetite-grünerite schist*.
2.5	White	C—Basal F—Conchoidal Brittle	2.7 2.9	Bitter saline taste. On exposure becomes coated with white powdery crust. With halite, thenardite, mirabilite.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Leadhillite $PbSO_4.2PbCO_3.Pb(OH)_2$	Monoclinic **C**—Tabular, pseudohexagonal; twins, trillings **M**—Compact, lamellar	Pearly Adamantine Transparent to translucent	White Gray Colorless
Kernite (Rasorite) $Na_2B_4O_7.4H_2O$	Monoclinic **C**—Large, resembling selenite **M**—Cleavable, fibrous	Vitreous Pearly Transparent to translucent	Colorless White
Kainite $MgSO_4.KCl.3H_2O$	Monoclinic **C**—Tabular, prismatic. rare **M**—Compact, fine grained	Vitreous Transparent to translucent	Colorless White Gray
TRONA $Na_2CO_3.NaHCO_3.2H_2O$	Monoclinic **C**—Tabular, acicular, columnar **M**—Crusts	Vitreous Pearly Translucent	Colorless Gray Yellowish white
Gibbsite (Hydrargillite) $Al(OH)_3$	Monoclinic **C**—Tabular, pseudohexagonal, rare **M**—Stalactitic, mammilliary, surface smooth, internal structure fibrous; scaly aggregates	Pearly Vitreous Translucent	White Grayish
CRYOLITE Na_3AlF_6	Monoclinic **C**—Small, pseudocubical rare **M**—Cleavable, compact, granular	Vitreous Greasy Pearly Transparent to translucent	Snow whit Gray Colorless
BARITE (Heavy spar) $BaSO_4$	Orthorhombic **C**—Tabular, prismatic; crested divergent groups **M**—Compact, cleavable, lamellar, fibrous, reniform	Vitreous Pearly Transparent to translucent	Colorless White Gray

Hardness 1 to 3

ard-ess	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
2.5	White	C—Basal, perfect F—Conchoidal, rarely observed Rather sectile	6.2 6.6	Soft and very heavy. Twins and trillings resemble those of aragonite. With lead minerals, but sparingly. Pseudomorphous after calcite, galena.
2.5 3.	White	C—Basal, orthopinacoidal, perfect F—Uneven Brittle	1.9	Cleavage angle about 70°. Breaks readily into fibers and laths. With other boron minerals,—borax, ulexite, colemanite.
2.5 3.	White	C—Pinacoidal, prismatic, not conspicuous F—Uneven Brittle	2. 2.2	Taste, salty, bitter and astringent. Non-hygroscopic. With halite, sylvite.
2.5 3.	White	C—Pinacoidal F—Uneven Brittle	2.1 2.2	Taste alkaline. Does not alter on exposure. As an efflorescence; in soda lakes. With halite, glauberite, mirabilite, hanksite.
2.5 3.	White	C—Basal, not conspicuous Tough	2.3 2.4	Slight clay odor when breathed upon. With bauxite, natrolite, limonite, corundum.
2.5 3.	White	C—Basal, prismatic, nearly at 90°; sometimes conspicuous F—Uneven Brittle	2.9 3.	Frequently resembles snow ice. Often contains disseminated siderite, chalcopyrite, galena, pyrite, fluorite, columbite.
2.5 3.	White	C—Basal, prismatic, conspicuous F—Uneven Brittle	4.3 4.7	Characterized by rather high specific gravity and cleavages. In metalliferous veins; pockets and lenticular masses in limestones. With galena, sphalerite, fluorite, chalcopyrite; manganese and iron ores.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Kieserite $MgSO_4.H_2O$	Monoclinic **C**—Pyramidal, rare **M**—Compact, granular	Vitreous Transparent to translucent	Colorless White Gray
CALCITE, varieties *Dog tooth spar* *Nail head spar* *Iceland spar* *Satin spar* *Limestone* *Coquina* *Marble* *Calcareous tufa* *Travertine* *Stalactites, etc.* *Thinolite* $CaCO_3$	Hexagonal **C**—Scalenohedral, rhombohedral, prismatic, tabular, acicular; highly modified; twins **M**—Cleavable, granular, fibrous, banded, stalactitic, oolitic, porous, compact, crusts shells	Vitreous Dull Transparent to nearly opaque	White Grayish Colorless
***Wulfenite** $PbMoO_4$	Tetragonal **C**—Square, thin tabular; more rarely pyramidal **M**—Coarse, fine grained	Adamantine Resinous Transparent to translucent	Gray Yellowish gray Greenish g

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Gibbsite (Hydrargillite) $Al(OH)_3$	Monoclinic **C**—Tabular, pseudohexagonal, rare **M**—Stalactitic, mammillary, surface smooth, internal structure fibrous	Pearly Vitreous Translucent	White Grayish
Polyhalite $K_2MgCa_2(SO_4)_4.2H_2O$	Monoclinic? **C**—Indistinct **M**—Compact, fibrous, lamellar	Greasy Pearly Translucent	White Reddish w Gray

* Uncommon color.

Hardness 1 to 3

rd-ss	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
	White	C—Pyramidal F—Granular Friable to firm	2.5 2.6	Due to absorption of water becomes coated with white crust of epsomite. With halite and potassium salts—carnallite, kainite, sylvite.
	White	C—Rhombohedral, perfect, usually conspicuous F—Conchoidal Brittle	2.7	Rhombohedral cleavage characteristic, especially on crystals. Cleavage surfaces often striated. Very strong double refraction easily observed when transparent.
	White	C—Indistinct F—Conchoidal, uneven Brittle	6.3 7.	Square plates, sometimes with forms of third order. With lead minerals—galena, pyromorphite, vanadinite.

Hardness 3 to 6

	White	C—Basal, not conspicuous Tough	2.3 2.4	Slight clay odor when breathed upon. Often as scaly aggregates. With bauxite, natrolite, limonite, corundum.
	White	F—Stalky, fibrous Brittle	2.7 2.8	Taste, bitter and astringent, but weak. With halite, anhydrite, gypsum, clay.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
ANHYDRITE $CaSO_4$	Orthorhombic **C**—Thick tabular, prismatic, rare **M**—Granular, compact, fibrous, cleavable, lamellar, reniform	Vitreous Pearly Transparent to translucent	White Bluish w Reddish Grayish
CELESTITE $SrSO_4$	Orthorhombic **C**—Tabular, prismatic, common; pyramidal **M**—Compact, cleavable fibrous, granular, reniform	Vitreous Pearly Transparent to translucent	Colorless White Bluish wh
BARITE (Heavy spar) $BaSO_4$	Orthorhombic **C**—Tabular, prismatic; crested divergent groups **M**—Compact, cleavable, lamellar, fibrous, reniform	Vitreous Pearly Transparent to translucent	Colorless White Greenish
ANGLESITE $PbSO_4$	Orthorhombic **C**—Prismatic, tabular, pyramidal **M**—Compact, granular, nodular	Adamantine Greasy Transparent to translucent	Colorless White Gray
CERUSSITE $PbCO_3$	Orthorhombic **C**—Tabular, prismatic, pyramidal; pseudo-hexagonal; clusters and star-shaped groups **M**—Interlaced bundles, granular, stalactitic, compact	Adamantine Greasy Silky Transparent to translucent	Colorless White Gray

Hardness 3 to 6

rd-ess	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
.5	White	C—Pinacoidal, 3 directions at 90°, sometimes conspicuous F—Conchoidal Brittle	2.7 3.	Pseudocubical cleavage sometimes noted. Granular varieties resemble marble or lumps of sugar. Not as heavy as celestite or barite. In limestones, shales. With halite, gypsum.
.5	White	C—Basal, prismatic, conspicuous F—Uneven Brittle	3.9 4.	Usually with faint bluish tinge. Heavier than calcite, anhydrite; lighter than barite. Good cleavages. In limestones, dolomites, shales. With sulphur, gypsum, aragonite, halite, galena, sphalerite.
.5	White	C—Basal, prismatic, conspicuous F—Uneven Brittle	4.3 4.7	Characterized by rather high specific gravity and cleavages. In metalliferous veins; pockets and lenticular masses in limestones. With galena, sphalerite, fluorite, chalcopyrite; manganese and iron ores.
.5	White	C—Basal, prismatic F—Conchoidal Brittle	6.1 6.4	Luster and very high specific gravity important. Distinguished from cerussite by absence of twins. Oxidation product of lead minerals. Usually in cracks and cavities, with galena, cerussite.
.5	White	C—Indistinct F—Conchoidal Brittle	6.4 6.6	Twinning, structure, luster, and specific gravity characteristic. With lead minerals—galena, pyromorphite, anglesite; also malachite, limonite.

Streak—Uncolored, white, or light gray

	Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
ZEOLITES	**STILBITE** (Desmine) $(Ca,Na_2)Al_2Si_6O_{16}.6H_2O$	Monoclinic **C**—Twinned, sheaf-like, radial, or globular aggregates	Vitreous Pearly Transparent to translucent	White Yellowish white Gray
	Heulandite $H_4CaAl_2(SiO_3)_6.3H_2O$	Monoclinic **C**—Tabular, striated **M**—Foliated, granular, globular	Vitreous Pearly Transparent to translucent	White Gray
	Laumontite $Ca(Al.2OH)_2(Si_2O_5)_2.2H_2O$	Monoclinic **C**—Columnar **M**—Radial, divergent, earthy	Vitreous Dull Transparent to opaque	White Reddish white Gray
	Lepidolite (Mica) $(Li,H)_2(F,OH)_2Al_2Si_3O_9$	Monoclinic **C**—Short prismatic **M**—Granular, coarse or fine; scales, cleavable plates	Pearly Translucent	White Pinkish Lavender Gray
	Margarite $H_2CaAl_4Si_2O_{12}$	Monoclinic **C**—Six-sided scales, plates **M**—Scaly, platy, foliated, granular	Pearly Vitreous Translucent	Pearl gray White Reddish
	PHOSPHATE ROCK (Apatite) Mainly calcium carbonate—phosphate (collophane)	Amorphous **M**—Compact, fibrous, nodular, reniform, earthy	Dull Opaque	White Gray
	ANDALUSITE Al_2SiO_5	Orthorhombic **C**—Prismatic, rough, nearly square, often large without terminations **M**—Columnar, fibrous, granular, disseminated	Vitreous Dull Transparent to opaque	White Pearl gray Reddish

Hardness 3 to 6

rd-ess	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
.	White	**C**—Pinacoidal **F**—Uneven Brittle	2.1 2.2	Radial or sheaf-like structure. In basic igneous rocks; ore deposits. With chabazite, apophyllite, heulandite, datolite, calcite.
.	White	**C**—Clinopinacoidal perfect **F**—Uneven Brittle	2.1 2.2	In basic igneous rocks; metalliferous veins. With chabazite, stilbite, apophyllite, datolite.
.	White	**C**—Clinopinacoidal, prismatic **F**—Uneven, earthy Brittle, friable	2.3	On exposure becomes dull and crumbles to powder. In cavities and fissures in basic igneous rocks. With stilbite, apophyllite, analcite, native copper.
.	White	**C**—Basal, perfect **F**—Scaly, granular Tough	2.8 2.9	When massive often resembles granular limestone. In pegmatites, granites, gneisses. With red tourmaline (rubellite), amblygonite, spodumene, topaz.
. 5	White	**C**—Basal, perfect, conspicuous **F**—Scaly, granular Tough	3.	Resembles the micas in structure and cleavage, but harder, laminæ brittle and inelastic. With chlorite, corundum, emery, diaspore.
.	White	**F**—Conchoidal, uneven Brittle	3.1 3.2	More or less impure masses, frequently resembling compact limestone. Independent beds, nodules, concretions.
.	White	**C**—Prismatic **F**—Uneven Brittle	3.1 3.2	Due to alteration, surface may be covered with scales of mica, hence, soft. *Chiastolite*, regular, internal arrangement of dark, organic matter, best seen in cross-section. In metamorphic rocks, often as rounded or knotty projections. With cyanite, sillimanite, garnet, tourmaline.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Wavellite $(Al.OH)_3(PO_4)_2.5H_2O$	Orthorhombic **C**—Capillary, small **M**—Crusts, globular or hemispherical, with radial fibrous structure	Vitreous Translucent	White Gray Colorless
ALUNITE (Alum stone) $K_2(Al.2OH)_6(SO_4)_4$	Hexagonal **C**—Rhombohedrons, resembling cubes; tabular, rare **M**—Compact, granular, fibrous, earthy	Vitreous Pearly Transparent to translucent	Colorless White Gray
DOLOMITE $CaMg(CO_3)_2$	Hexagonal **C**—Rhombohedral with curved surfaces (*pearl spar*) **M**—Coarsely crystalline, compact, granular, friable	Vitreous Pearly Transparent to translucent	White Gray Colorless
ARAGONITE $CaCO_3$	Orthorhombic **C**—Chisel- or spear-shaped; pseudohexagonal prisms; radial, columnar, acicular aggregates **M**—Branching forms (*flos ferri*), stalactitic, reniform, crusts, oolitic	Vitreous Greasy Transparent to translucent	Colorless White Gray
STRONTIANITE $SrCO_3$	Orthorhombic **C**—Spear-shaped, columnar, acicular, often divergent **M**—Granular, compact, fibrous, botryoidal	Vitreous Transparent to translucent	Colorless Gray White
***SIDERITE** $FeCO_3$	Hexagonal **C**—Rhombohedral, curved or saddle-shaped **M**—Cleavable, granular, compact, botryoidal	Vitreous Pearly Translucent	Gray Brownish Yellowish

* Uncommon color.

Hardness 3 to 6

Hardness	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
3.5 4.	White	C—Pinacoidal, domatic F—Uneven, conchoidal Brittle	2.3 2.4	Secondary mineral, occurring on surfaces of rocks or minerals as crystalline crusts with pronounced radial, fibrous structure.
3.5 4.	White	C—Basal F—Splintery, conchoidal, earthy Brittle	2.6 2.8	Hardness often greater due to admixture of quartz, feldspar; then tough. Deposits and veins in feldspathic rocks. With kaolin, pyrite, opal.
3.5 4.	White Gray	C—Rhombohedral, perfect (crystals) F—Conchoidal Brittle	2.9	Crystals generally curved or saddle-shaped with pearly luster. *Marble* includes some compact varieties. Independent beds; in fissures and cavities; with ore deposits.
3.5 4.	White	C—Pinacoidal, prismatic, indistinct F—Conchoidal Brittle	2.9 3.	Twins common, often pseudohexagonal—prism and striated base. In cracks and cavities; with ore deposits; deposition from hot springs; in shells. With gypsum, celestite, sulphur, siderite, serpentine.
3.5 4.	White	C—Indistinct F—Uneven Brittle	3.6 3.8	Similar to aragonite. Divergent columnar structure and higher specific gravity characteristic. In ore deposits; independent masses. With galena, barite, calcite.
3.5 4.	White Gray	C—Rombohedral, perfect, conspicuous F—Conchoidal Brittle	3.7 3.9	Curved crystals and rhombohedral cleavage important. In ore deposits; beds and concretions in limestone, shale. With pyrite, chalcopyrite, galena, tetrahedrite, cryolite.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
*SPHALERITE, variety *Cleiophane* ZnS	Cubic C—Tetrahedral M—Cleavable, compact, granular	Adamantine Vitreous Transparent to translucent	White Colorless
WITHERITE $BaCO_3$	Orthorhombic C—Pseudohexagonal bipyramids resembling quartz M—Radial fibrous, compact, globular, granular, lamellar	Vitreous Greasy Translucent to transparent	White Grayish Colorless
*PYROMORPHITE $Pb_5Cl(PO_4)_3$	Hexagonal C—Prismatic, thick tabular; rounded barrel-shaped; acicular M—Globular, reniform, disseminated, crusts	Greasy Adamantine Translucent to opaque	White Gray Colorless
*Mimetite $Pb_5Cl(AsO_4)_3$	Hexagonal C—Prismatic, tabular, rounded barrel-shaped M—Globular, reniform, crusts	Greasy Adamantine Translucent	White Colorless
Colemanite $Ca_2B_6O_{11}.5H_2O$	Monoclinic C—Prismatic, highly modified M—Granular, cleavable, compact	Vitreous Dull Transparent to opaque	Colorless Milky white Yellowish white
*RHODOCHROSITE $MnCO_3$	Hexagonal C—Rhombohedral, rare M—Cleavable, granular, compact, botryoidal, crusts	Vitreous Pearly Translucent	Reddish w Yellowish gray
MAGNESITE $MgCO_3$	Hexagonal C—Rhombohedral, rare M—Compact, granular, resembling unglazed porcelain on fresh fracture	Vitreous Dull Translucent to transparent	Snow whit Gray Colorless

* Uncommon color.

Hardness 3 to 6

ard- ness	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
3.5 4.	White	C—Dodecahedral, sometimes conspicuous F—Conchoidal Brittle	3.9 4.2	Uncommon color. Color and streak vary with impurities. In limestone. With franklinite, willemite, zincite, smithsonite.
3.5 4.	White	C—Indistinct F—Uneven Brittle	4.2 4.3	Crystals, apparently hexagonal bipyramids; massive, often radial fibrous resembling strontianite, but heavier. Usually with galena.
3.5 4.	White	C—None F—Conchoidal, uneven Brittle	6.5 7.1	Common alteration product of lead minerals. With galena, cerussite, mimetite, barite, limonite.
3.5 4.	White	C—Indistinct F—Uneven Brittle	7. 7.3	Resembles pyromorphite, but not as common. With lead minerals —galena, pyromorphite.
3.5 4.5	White	C—Pinacoidal, perfect, conspicuous F—Uneven, conchoidal Brittle	2.2 2.4	Transparent crystals, resemble those of datolite, but softer; compact masses look like chalk or porcelain. With gypsum, celestite, quartz.
3.5 4.5	White	C—Rhombohedral, perfect, conspicuous F—Uneven Brittle	3.3 3.6	May turn brown to black on exposure, due to MnO_2. In ore deposits. With galena, sphalerite, pyrite, alabandite, wad, psilomelane.
3.5 5.	White	C—Rhombohedral, perfect (crystals) F—Conchoidal, conspicuous Tough to brittle	2.9 3.1	Conchoidal fracture generally prominent. Compact varieties are apparently very hard. Disseminated in talcose and chloritic schists, serpentine, gypsum; independent beds.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
FLUORITE (Fluor spar) CaF_2	Cubic **C**—Cubes, alone or modified, well developed **M**—Cleavable, granular, fibrous	Vitreous Transparent to translucent	Colorless White Greenish wh
ZEOLITES **CHABAZITE** $CaAl_2Si_6O_{16}.8H_2O$, etc.	Hexagonal **C**—Rhombohedral, cube-like; lenticular **M**—Compact	Vitreous Translucent to transparent	White Colorless Gray
ZEOLITES **APOPHYLLITE** $H_{14}K_2Ca_8(SiO_3)_{16}.9H_2O$	Tetragonal **C**—Prismatic, pyramidal, pseudocubical, tabular **M**—Lamellar, granular compact	Vitreous Pearly Transparent to nearly opaque	Colorless White Yellowish white
ZEOLITES **Harmotome** $BaAl_2Si_6O_{16}.6H_2O$, etc.	Monoclinic **C**—Usually twins, penetrating at 90°	Vitreous Translucent	White Gray
Pectolite, (Pyroxene) $(Ca,Na_2)_2(SiO_3)_2$	Monoclinic **C**—Acicular, rarely terminated; tabular **M**—Compact radial fibrous aggregates	Vitreous Silky Translucent to opaque	White Grayish
CYANITE, (Disthene, kyanite) Al_2SiO_5	Triclinic **C**—Long, bladed, without good terminations; sometimes curved and radially grouped **M**—Coarsely bladed, columnar, fibrous	Vitreous Translucent to transparent	White Bluish whi Colorless

Hardness 3 to 6

ard- ess	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
4. 5.	White	C—Octahedral, perfect, conspicuous Brittle	3. 3.2	Recognized by crystal form, octahedral cleavage, and hardness. Common gangue of metallic ores, especially galena, sphalerite, cassiterite; also with calcite, barite.
4. 5.	White	C—Rhombohedral, not conspicuous F—Uneven Brittle	2.1 2.	Generally in cube-like crystals. Inferior cleavage distinguishes it from fluorite. In basic igneous rocks. With analcite, stilbite, heulandite, harmotome.
4. 5.	White	C—Basal, perfect, conspicuous F—Uneven Brittle	2.3 2.4	Fish-eye opalescence often observed on basal pinacoid. Prism faces vertically striated. In fissures and cavities in basic igneous rocks. With natrolite, analcite, laumontite, datolite, prehnite, native copper, calcite.
4. 5.	White	C—Pinacoidal F—Uneven Brittle	2.4 2.5	Cruciform twins, often milky or cloudy. In basic igneous rocks and metalliferous veins. With chabazite, calcite, quartz, adularia. *Phillipsite*, contains calcium replacing barium.
4. 5.	White Grayish	C—Basal, orthopinacoidal F—Uneven, fibrous Brittle	2.7 2.8	Fibers usually divergent, long, and very sharp. In fissures and cavities in basic igneous and metamorphic rocks. With zeolites, prehnite, datolite.
4. 5.	White	C—Pinacoidal, perfect, conspicuous Brittle	3.5 3.7	Often with bluish streaks or spots irregularly distributed. Hardness varies with direction, 4–5 parallel to long direction, 6–7 at right angles thereto. In gneiss, mica schist. With staurolite, garnet, corundum.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Scheelite $CaWO_4$	Tetragonal **C**—Pyramidal, small; more rarely tabular **M**—Drusy crusts, compact, reniform, granular, disseminated	Adamantine Greasy Transparent to translucent	Gray White Yellowish white
Wollastonite (Pyroxene, tabular spar) $CaSiO_3$	Monoclinic **C**—Tabular, prismatic **M**—Cleavable, fibrous, granular, compact	Vitreous Silky Transparent to translucent	White Gray Colorless
APATITE $Ca_5F(PO_4)_3$	Hexagonal **C**—Prismatic, thick tabular **M**—Compact, fibrous, nodular, reniform	Vitreous Greasy Transparent to translucent	White Gray Colorless
HEMIMORPHITE (Calamine) $H_2Zn_2SiO_5$	Orthorhombic **C**—Thin tabular, pyramidal, hemimorphic, highly modified **M**—Compact, globular, stalactitic, fibrous, granular, cellular, earthy	Vitreous Dull Transparent to opaque	Colorless White Gray
SMITHSONITE $ZnCO_3$	Hexagonal **C**—Small, usually as druses or crusts **M**—Botryoidal, stalactitic, granular, cellular, fibrous, compact	Vitreous Pearly Dull Transparent to nearly opaque	White Brownish white Gray Colorless
ZEOLITES **ANALCITE** $Na_2Al_2(SiO_3)_4 . 2H_2O$	Cubic **C**—Tetragonal trisoctahedrons, cubes **M**—Granular, compact	Vitreous Transparent to nearly opaque	Colorless White Grayish
ZEOLITES **Natrolite** $Na_2Al(AlO)(SiO_3)_3 . 2H_2O$	Orthorhombic **C**—Slender prismatic, nearly square; radial or interlacing groups **M**—Fibrous, granular, compact	Vitreous Silky Transparent to translucent	White Colorless Grayish

Hardness 3 to 6

ard-ess	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
4.5	White	C—Pyramidal, not conspicuous F—Conchoidal, uneven Brittle	5.9 6.2	Small, well developed octahedral-like crystals, usually on quartz; when massive high specific gravity important. With cassiterite, wolframite, fluorite, apatite, molybdenite.
4.5 5.	White	C—Basal, orthopinacoidal F—Uneven Brittle	2.8 2.9	Fibers may be parallel or divergent. Typical contact mineral often in crystalline limestone. With garnet, diopside, vesuvianite, graphite.
4.5 5.	White	C—Basal, imperfect F—Conchoidal, uneven Brittle	3.1 3.2	Crystals may be vertically striated and highly modified. In crystalline limestone; ore deposits, igneous rocks. With quartz, cassiterite, fluorite, wolframite.
4.5 5.	White	C—Prismatic F—Uneven, conchoidal Brittle	3.3 3.5	Crystals often in sheaf-like groups or druses in cavities. When massive may be porous. In limestones. With sphalerite, galena, and especially smithsonite.
5.	White Gray	C—Rhombohedral, not often observed F—Uneven, splintery Brittle	4.1 4.5	Cellular varieties are called *dry bone*. Often mixed with sand, clay, limonite, calcite. With zinc minerals, especially sphalerite, hemimorphite. Frequently as a pseudomorph after calcite.
5. 5.5	White	C—None F—Uneven, conchoidal Brittle	2.2 2.3	Good crystals common. In fissures and cavities in basic igneous rocks. With apophyllite, chabazite, natrolite, datolite, native copper, prehnite, epidote.
5. 5.5	White	C—Prismatic F—Uneven Brittle	2.2 2.3	Needle-like crystals have nearly square cross-section. With chabazite, analcite, apophyllite, stilbite, prehnite, datolite.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Thomsonite (Zeolite) $2(Ca,Na_2)Al_2(SiO_4)_2.5H_2O$	Orthorhombic **C**—Prismatic, vertically striated; divergent groups **M**—Fibrous, columnar, radial; spherical concretions, compact	Vitreous Silky Pearly Transparent to translucent	Snow whit Reddish w Yellowish white Colorless
Datolite $Ca(B.OH)SiO_4$	Monoclinic **C**—Prismatic, pyramidal, tabular, highly modified **M**—Compact fibrous, granular, botryoidal	Vitreous Greasy Dull Transparent to opaque	Colorless Greenish white Gray
***Sodalite** $Na_4Al_2(AlCl)(SiO_4)_3$	Cubic **C**—Dodecahedral **M**—Compact, disseminated grains, nodular	Vitreous Greasy Transparent to translucent	White Gray Colorless
***Cancrinite** $H_6(Na_2,Ca)_4(NaCO_3)_2Al_3Si_9O_{36}$	Hexagonal **C**—Prismatic, rare **M**—Compact, lamellar, columnar, disseminated	Vitreous Pearly Greasy Transparent to translucent	White Yellowish white Gray
NEPHELITE (Nepheline, elæolite) $(Na,K)_3Al_3Si_9O_{34}$	Hexagonal **C**—Short prismatic, tabular **M**—Compact, disseminated grains	Greasy Vitreous Transparent to opaque	White Bluish gr Greenish Colorless
SCAPOLITE (Wernerite) $\{ nNa_4Al_3Si_9O_{24}Cl$ $\{ mCa_4Al_6Si_6O_{25}$	Tetragonal **C**—Thick prismatic, coarse, often large **M**—Compact, fibrous, columnar, granular	Vitreous Greasy Translucent	White Gray Greenish

* Uncommon color.

Hardness 3 to 6

ard-ess	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
5. 5.5	White	C—Pinacoidal F—Uneven Brittle	2.3 2.4	Crystals small, usually colorless and transparent. When massive, radial fibrous, often mottled or banded. With stilbite, analcite, prehnite, calcite.
5. 5.5	White	C—None F—Conchoidal, uneven Brittle	2.9 3.	Crystals glassy, often with greenish tinge; compact masses resemble wedgewood ware or unglazed porcelain; often with reddish, brownish, or yellowish streaks and spots. In cracks and cavities in basic igneous rocks. With prehnite, native copper, calcite, zeolites.
5. 5.	White	C—Dodecahedral F—Conchoidal, uneven Brittle	2.2 2.4	May be slightly colored. Recognized by associates—nephelite, cancrinite, leucite, zircon, feldspar; not with quartz.
. .	White	C—Prismatic F—Uneven Brittle	2.4 2.5	Associates important—sodalite, nephelite, biotite, feldspar, titanite.
. .	White	C—Indistinct F—Conchoidal, uneven Brittle	2.6	Distinguished from orthoclase by inferior cleavage and more greasy luster. With feldspar, cancrinite, biotite, sodalite, zircon, corundum; not with quartz.
. .	White	C—Prismatic F—Conchoidal Brittle	2.6 2.8	Crystals may appear as though fused. Typical contact mineral. In metamorphic rocks, especially granular limestones. With pyroxenes, amphiboles, apatite, garnet, biotite.

Streak—Uncolored, white, or light gray

	Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
AMPHIBOLES	**Tremolite** $Ca_2Mg_5H_2(SiO_3)_8$	Monoclinic **C**—Bladed, without terminations **M**—Compact, columnar, granular	Silky Vitreous Transparent to opaque	White Yellowish white Colorless
	ANTHOPHYLLITE $(Mg,Fe)_4(SiO_3)_4$	Orthorhombic **C**—Prismatic, rare **M**—Lamellar, columnar, fibrous	Vitreous Pearly Translucent	Gray Brownish Greenish
PYROXENES	***ENSTATITE** $Mg_2(SiO_3)_2$	Orthorhombic **C**—Prismatic, rare **M**—Fibrous, lamellar, columnar, compact	Vitreous Pearly Translucent to opaque	Grayish Greenish Yellowish white
	DIOPSIDE $CaMg(SiO_3)_2$	Monoclinic **C**—Prismatic, thick columnar, prism angle 87° **M**—Compact, granular, lamellar, columnar	Vitreous Dull Transparent to opaque	Gray Greenish Yellowish white Colorless
	***Willemite** Zn_2SiO_4	Hexagonal **C**—Prismatic, rare **M**—Compact, granular, disseminated grains	Vitreous Transparent to opaque	White Gray Colorless
	OPAL, varieties *Precious opal* *Milk opal* *Wood opal* *Hyalite* *Silicious sinter* *Tripolite* $SiO_2.nH_2O$	Amorphous **M**—Reniform, botryoidal, porous, earthy, compact	Vitreous Pearly Dull Transparent to opaque	Colorless Gray Milk white Yellowish white
	LEUCITE $K_2Al_2Si_4O_{12}$	Pseudocubic **C**—Tetragonal trisoctahedrons **M**—Rounded disseminated grains	Vitreous Greasy Translucent to opaque	Gray White Yellowish white
	Amblygonite $Li(AlF)PO_4$	Triclinic **C**—Rare **M**—Cleavable, compact, columnar	Pearly Vitreous Translucent	White Yellowish white Gray

* Uncommon color.

Hardness 3 to 6

rd-ss	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
	White	C—Prismatic, conspicuous—124° Brittle	2.9 3.1	Silky luster and distinct cleavage (124°) important. Common contact mineral. In limestones, dolomites, schists.
	White Grayish	C—Prismatic F—Fibrous Brittle	3.1 3.2	Softer when altered. In crystalline schists. With talc, hornblende, mica.
	White Grayish	C—Prismatic, pinacoidal F—Uneven Brittle	3.1 3.3	Often softer due to alteration to serpentine. In basic igneous rocks. With olivine, serpentine, chondrodite, talc.
	White Gray	C—Prismatic; conspicuous basal parting F—Uneven Brittle	3.2 3.3	Prismatic, pseudotetragonal crystals, with distinct basal parting. May show colorless and dark green zones. In crystalline limestones. With vesuvianite, garnet, scapolite, spinel, apatite.
	White	C—Basal F—Uneven Brittle	3.9 4.3	Characterized by associates—franklinite, zincite, rhodonite, calcite.
5	White	F—Conchoidal, conspicuous when compact; earthy Brittle	2.1 2.3	*Precious opal,* with play of colors; *milk opal,* compact, milk white; *wood opal,* woody structure; *hyalite,* resembles drops of melted glass; *silicious sinter,* porous or botryoidal; *tripolite,* earthy and gritty.
5	White	C—Indistinct F—Conchoidal Brittle	2.5	Well developed crystals or rounded grains, disseminated in eruptive rocks. With sanidine, augite, nephelite, olivine.
	White	C—Basal, conspicuous; macropinacoidal, domatic F—Uneven Brittle	3. 3.1	Usually in cleavable masses, showing distinct cleavage in one direction. Resembles orthoclase. With lepidolite, rubellite, topaz, petalite.

Streak—Uncolored, white, or light gray

	Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
FELDSPARS	**ORTHOCLASE,** varieties *Adularia* $KAlSi_3O_8$ *Sanidine* *Ordinary*	Monoclinic **C**—Prismatic, thick tabular; twins; often large **M**—Cleavable, granular, disseminated	Vitreous Pearly Translucent to transparent	White Gray Colorless
	MICROCLINE $KAlSi_3O_8$	Triclinic **C**—Prismatic, thick tabular; twins; often large **M**—Cleavable, granular, disseminated	Vitreous Pearly Translucent to transparent	Gray White Yellowish white
	Plagioclases **ALBITE** $NaAlSi_3O_8$(Ab)	Triclinic **C**—Tabular, twins, small **M**—Compact, curved or divergent lamellar, granular	Vitreous Pearly Transparent to translucent	White Gray Colorless
	Oligoclase $Ab\ldots\ldots Ab_3An_1$	Triclinic **C**—Tabular, rare **M**—Compact, cleavable, granular	Vitreous Pearly Greasy Transparent to translucent	Gray White Colorless
	LABRADORITE $Ab_1An_1\ldots Ab_1An_3$	Triclinic **C**—Thin tabular, often with rhombic cross-section **M**—Compact, cleavable, granular	Vitreous Pearly Translucent to nearly opaque	Gray Greenish White
	Anorthite $CaAl_2Si_2O_8$(An)	Triclinic **C**—Prismatic, tabular complex **M**—Compact, cleavable, lamellar	Vitreous Pearly Transparent to translucent	Colorless White Gray

Hardness over 6

rd-ss	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
5	White	C—Basal, clinopinacoidal, conspicuous, 90°; often steplike F—Conchoidal, uneven Brittle	2.5 2.6	Distinguished from other feldspars by rectangular cleavage and absence of twinning striations. *Adularia*, opalescent, transparent or slightly cloudy; *sanidine*, glassy, tabular or square crystals. With quartz, other feldspars, mica, hornblende, zircon.
5	White	C—Basal, brachypinacoidal, conspicuous, 90° 30′ F—Uneven Brittle	2.5 2.6	Resembles orthoclase, but with slightly inclined cleavages and may show twinning striations on basal pinacoid. Occurrence and associates same as for orthoclase.
5	White	C—Basal, brachypinacoidal, conspicuous, 86° 24′ F—Uneven Brittle	2.6	Inclined cleavages often show fine, parallel twinning striations. *Moonstone*, opalescent. With quartz, other feldspars, mica, chlorite, axinite, beryl, rutile.
5	White	C—Basal, brachypinacoidal, conspicuous, 86° 32′ F—Uneven Brittle	2.7	Commonly glassy with inclined cleavages showing parallel striations. In granitic rocks. With quartz, other feldspars, mica, garnet, tourmaline. *Aventurine oligoclase* or *sunstone*, contains disseminated scales yielding yellowish or reddish reflections.
5	White	C—Basal, brachypinacoidal, conspicuous, 86° 4′ F—Uneven Brittle	2.7	Often with play of colors— yellow, green, blue, red. Inclined cleavages are striated. In basic igneous rocks. With pyroxenes, amphiboles.
5	White	C—Basal, brachypinacoidal, conspicuous, 85° 50′ F—Uneven Brittle	2.7 2.8	Commonly in small, glassy, highly modified crystals. In basic igneous rocks; crystalline limestones. With olivine, pyroxenes, pyrrhotite, magnetite.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
Prehnite $H_2Ca_2Al_2(SiO_4)_3$	Orthorhombic **C**—Tabular, prismatic; curved, sheaf-like groups **M**—Botryoidal, stalactitic, radial fibrous	Vitreous Waxy Transparent to translucent	White Greenish white Grayish w
SPODUMENE (Pyroxene) $LiAl(SiO_3)_2$	Monoclinic **C**—Prismatic, tabular, vertically striated **M**—Cleavable, broad columnar	Vitreous Pearly Transparent to opaque	White Grayish w Greenish white
Sillimanite (Fibrolite) Al_2SiO_5	Orthorhombic **C**—Long, thin, needle-like **M**—Fibrous, columnar, radiating	Vitreous Silky Transparent to translucent	Gray Yellowish Grayish w
***Axinite** $M_7''M_4'''B_2(SiO_4)_8$ $M'' = Ca,Fe,Mn,Mg$ $M''' = Al,Fe$	Triclinic **C**—Broad tabular, sharp edges **M**—Lamellar, granular	Vitreous Transparent to translucent	Pearl gra
Zoisite $Ca_2Al_2(Al.OH)(SiO_4)_3$	Orthorhombic **C**—Prismatic, deeply striated, bent, without good terminations **M**—Columnar, broad bladed, fibrous	Vitreous Pearly Transparent to opaque	Gray Greenish White Colorless
Diaspore $AlO.OH$	Orthorhombic **C**—Broad columnar, tabular, rare **M**—Scaly, confused fibrous or bladed aggregates	Vitreous Pearly Transparent to translucent	Colorless Grayish Lavende

* Uncommon color.

Hardness over 6

rd-ess	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
. .	White	C—Basal, not conspicuous F—Uneven Brittle	2.8 3.	Massive varieties usually have rough crystalline surfaces and internal radial, fibrous structure. In veins and cavities in basic igneous rocks. With pectolite, datolite, epidote, native copper, zeolites.
. .	White	C—Prismatic; pinacoidal parting conspicuous F—Uneven, splintery Brittle	3.1 3.2	Commonly in broad plates due to distinct pinacoidal parting. Prism angle 93°. May have irregular brownish stains. In granitic rocks. With tourmaline, lepidolite, beryl, amblygonite.
. .	White	C—Macropinacoidal F—Uneven Brittle	3.2 3.3	Crystals often slender, bent, striated, with rounded edges, without good terminations, and interlaced. In metamorphic rocks—mica schist, gneiss. With andalusite, zircon, iolite.
. .	White	C—Pinacoidal F—Conchoidal Brittle	3.3	Crystals sharp wedge-shaped, glassy, frequently coated and intergrown with green chlorite. With quartz, adularia, albite, tourmaline, hornblende.
. .	White	C—Brachypinacoidal, perfect, conspicuous F—Uneven Brittle	3.3 3.4	Deeply furrowed and transversely broken, columnar masses. In crystalline schists. With hornblende, vesuvianite, cyanite, epidote, garnet, feldspar, quartz.
.	White	C—Brachypinacoidal, conspicuous F—Conchoidal Brittle	3.3 3.5	With corundum, emery, dolomite, margarite, chlorite, magnetite.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
CYANITE (Disthene, kyanite) Al_2SiO_5	Triclinic **C**—Long, bladed, without good terminations; sometimes curved and radially grouped **M**—Coarsely bladed, columnar, fibrous	Vitreous Translucent to transparent	White Bluish whi Colorless
ANDALUSITE Al_2SiO_5	Orthorhombic **C**—Prismatic, rough, nearly square, often large, without terminations **M**—Columnar, fibrous, granular, disseminated	Vitreous Dull Translucent to opaque	White Pearl gray Reddish g
GARNET, variety *Grossularite* $Ca_3Al_2(SiO_4)_3$	Cubic **C**—Dodecahedrons, tetragonal trisoctahedrons, alone or in combination **M**—Granular, compact, lamellar, disseminated grains	Vitreous Transparent to translucent	Colorless White Greenish Yellowish white
QUARTZ, Crystalline varieties *Rock crystal* *Milky quartz* *Ordinary* SiO_2	Hexagonal **C**—Prismatic, horizontally striated columnar **M**—Compact, granular,	Vitreous Greasy Transparent to translucent	Colorless White Gray Milky
Cryptocrystalline varieties *Chalcedony* *Agate* *Onyx* *Hornstone* *Chert*	Hexagonal **C**—Never in crystals **M**—Nodular, botryoidal, banded, clouded, concretionary, stalactitic, compact	Waxy Vitreous Translucent to opaque	White Gray

(Quartz continued on next page.)

Hardness over 6

ard-ess	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
6. 7.	White	C—Pinacoidal, perfect, conspicuous Brittle	3.5 3.7	Often with bluish streaks or spots, irregularly distributed. Hardness varies with direction, 4–5 parallel to long direction, 6–7 at right angles thereto. In gneiss, mica schist. With staurolite, corundum, garnet.
6. 7.5	White	C—Prismatic F—Uneven Brittle	3.1 3.2	Due to alteration, surface may be coated with scales of mica, then softer. In metamorphic rocks, often as rounded or knotty projections. With cyanite, sillimanite, garnet.
6.5 7.5	White	C—Dodecahedral, usually indistinct F—Conchoidal, uneven Brittle	3.4 3.7	Typical contact mineral, in crystalline limestones and dolomites. With wollastonite, vesuvianite, diopside, scapolite.
7.	White	C—Indistinct F—Conchoidal, conspicuous Brittle	2.6	Characteristic conchoidal fracture and glassy luster. *Rock crystal*, colorless, or nearly so, and generally crystallized; *milky quartz*, milk white and nearly opaque.
7.	White	C—Indistinct F—Conchoidal, conspicuous Brittle to tough	2.6	Not as glassy as crystalline varieties. *Chalcedony, hornstone, chert*, uniform in color; *agate, onyx*, clouded or banded.

Streak—uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
QUARTZ, Clastic varieties *Sand* *Sandstone* *Itacolumite* *Quartzite* SiO_2	Hexagonal **M**—Grains, fragments, either loose or strongly consolidated	Vitreous Dull Translucent to opaque	Gray White
Boracite $Mg_7Cl_2B_{16}O_{30}$	Pseudocubic **C**—Tetrahedral, cubical, small, well developed **M**—Compact, nodular, fine fibrous	Vitreous Transparent to opaque	Colorless White Gray
***Iolite** (Cordierite) $(Mg,Fe)_4Al_8(OH)_2(Si_2O_7)_5$	Orthorhombic **C**—Short prismatic, pseudohexagonal **M**—Compact, disseminated grains, granular	Vitreous Dull Transparent to translucent	Gray Bluish gray Colorless
Danburite $CaB_2(SiO_4)_2$	Orthorhombic **C**—Prismatic, highly modified **M**—Disseminated	Vitreous Greasy Transparent to translucent	Colorless Yellowish white
***TOURMALINE** $M'_{20}B_2Si_4O_{21}$ M′ = Na,K,Li,Mg, Ca,(OH),Fe,Al	Hexagonal **C**—Prismatic, vertically striated; terminated with broken or rhombohedral-like surfaces	Vitreous Transparent to translucent	Colorless White Gray
Phenacite Be_2SiO_4	Hexagonal **C**—Rhombohedral, prismatic, pyramidal, lenticular; highly modified	Vitreous Transparent to translucent	Colorless White Yellowish white
ZIRCON $ZrSiO_4$	Tetragonal **C**—Square prisms with bipyramids, small, well developed **M**—Irregular lumps, grains	Adamantine Vitreous Pearly Transparent to opaque	Brownish gray Lavender gray Colorless

* Uncommon color.

Hardness over 6

Hard-ness	Streak	Cleavage =C Fracture =F Tenacity	Specific Gravity	Characteristics and Associates
7.	White	C—Indistinct F—Uneven Brittle to tough	2.6	*Sand*, loose, unconsolidated grains; *sandstone*, consolidated sand; *itacolumite*, flexible sandstone; *quartzite*, metamorphosed sandstone.
7.	White	C—None F—Conchoidal, uneven Brittle	2.9 3.	Disseminated glassy crystals common; compact masses resemble fine grained marble. With gypsum, anhydrite, halite, carnallite.
7. 7.5	White	C—Pinacoidal, sometimes conspicuous F—Conchoidal, uneven Brittle	2.6 2.7	When fresh, glassy and hard resembling quartz; usually altered, then dull and softer. With quartz, feldspar, hornblende, sillimanite, andalusite.
7. 7.5	White	C—Indistinct F—Uneven, conchoidal Brittle	2.9 3.	Resembles topaz, but cleavage not as perfect. With calcite, dolomite, mica, microcline, pyroxene, tourmaline.
7. 7.5	White	C—None F—Uneven, conchoidal Brittle	2.9 3.2	Spherical triangular cross-section. Often with zones of red or green. In pegmatites; metamorphic rocks; alluvial deposits. With quartz, feldspar, cassiterite, beryl, topaz, fluorite.
7. 8.	White	C—Indistinct F—Conchoidal Brittle	3.	Distinguished from quartz and topaz by crystal form and cleavage. In pegmatites and metamorphic rocks. With quartz, topaz, beryl, amazonstone, chrysoberyl.
7.5	White	C—Indistinct F—Uneven Brittle	4.4 4.8	In acid igneous rocks—granite, syenite; alluvial deposits, with gold, spinel, corundum, garnet. *Jargon*, colorless or smoky.

Streak—Uncolored, white, or light gray

Name Composition	Crystallization Structure Crystals = C Massive = M	Luster Transparency	Color
BERYL $Be_3Al_2(SiO_3)_6$	Hexagonal **C**—Long prismatic, often vertically striated, large **M**—Columnar, granular, compact	Vitreous Transparent to translucent	White Yellowish white Greenish white Colorless
LAWSONITE $Ca(Al.OH)_2(SiO_3)_2$	Orthorhombic **C**—Prismatic, tabular, six-sided **M**—Lenticular plates	Vitreous Greasy Transparent to opaque	Bluish white Bluish gray Colorless
TOPAZ $Al_2(F,OH)_2SiO_4$	Orthorhombic **C**—Prismatic, vertically striated, highly modified **M**—Compact, granular, rolled fragments	Vitreous Transparent to opaque	Colorless White Grayish
***Chrysoberyl** $Be(AlO_2)_2$	Orthorhombic **C**—Tabular; heart shaped and pseudo-hexagonal twins **M**—Fragments, loose rounded grains	Vitreous Greasy Transparent to translucent	Greenish white Yellowish white
CORUNDUM Al_2O_3	Hexagonal **C**—Prismatic, tabular, pyramidal, rhombohedral; rough or rounded barrel-shaped **M**—Compact, granular, lamellar	Vitreous Translucent to transparent	Gray Greenish g Bluish gra
DIAMOND C	Cubic **C**—Octahedrons, hexoctahedrons, usually with curved surfaces **M**—Rounded or irregular grains or pebbles, often with internal radial structure	Adamantine Greasy Transparent to translucent	Colorless Gray White

* Uncommon color.

Hardness over 5

ard-ness	Streak	Cleavage = C Fracture = F Tenacity	Specific Gravity	Characteristics and Associates
7.5 8.	White	C—Indistinct F—Conchoidal, uneven Brittle	2.6 2.8	Crystals usually simple—prism and base. In granitic rocks, mica schists, clay slates. With quartz, feldspars, mica, chrysoberyl, garnet, topaz, tourmaline.
7.5 8.	White	C—Pinacoidal, perfect F—Uneven Brittle	3.1	Fresh crystals are colorless, due to alteration covered with white or gray spots. Resembles corundum but not as heavy. In schists with actinolite, chlorite, margarite, epidote, garnet.
8.	White	C—Basal, perfect, conspicuous F—Conchoidal, uneven Brittle	3.4 3.6	Crystals usually developed on one end only. Massive varieties distinguished from quartz by higher specific gravity and basal cleavage. In veins and cavities in granitic rocks; alluvial deposits. With cassiterite, tourmaline, fluorite, beryl, scheelite, wolframite.
8.5	White	C—Brachypinacoidal F—Uneven, conchoidal Brittle	3.5 3.8	Crystals disseminated as plates, often with feather-like or radial striations. In mica schists, granite, gneiss, placers. With beryl, garnet, tourmaline, sillimanite.
9.	White	C—None, nearly rectangular basal and rhombohedral partings conspicuous; often striated F—Conchoidal Brittle to tough	3.9 4.1	When massive often multicolored—blue, green, red, yellow. In limestones, granites, syenites, schists, alluvial deposits. With magnetite, nephelite, mica, spinel, chlorite.
0.	Ash gray	C—Octahedral, perfect, usually conspicuous F—Conchoidal Brittle	3.5	May be tinged yellow, brown, red, blue. In serpentine rocks—kimberlite, peridotite, called *blue ground;* placers, with pyrope, magnetite, chromite, cassiterite, zircon, gold.

TABLE OF MINERALS ARRANGED ACCORDING TO INCREASING SPECIFIC GRAVITY,—WITH CHEMICAL COMPOSITION AND OTHER PHYSICAL PROPERTIES

Specific Gravity	Mineral	Composition	Hardness	Crystallization
0.9– 1.0	Ozocerite	C_nH_{2n+2}	1.	Amorphous
1.0– 1.1	Amber	$C_{40}H_{64}O_4$	2. –2.5	Amorphous
1.0– 1.8	Asphalt	C,H,O, etc.	1. –3.	Amorphous
1.0– 2.0	Sepiolite (Merschaum)	$H_4Mg_2Si_3O_{10}$	2. –2.5	Monoclinic
1.1– 1.5	Bituminous Coal	C,H,O, etc.	2. –2.5	Amorphous
1.3– 1.7	Anthracite Coal	C	2. –2.5	Amorphous
1.4– 1.5	Mirabilite (Glauber Salt)	$Na_2SO_4.10H_2O$	1.5–2.	Monoclinic
1.4– 1.5	Natron (Soda)	$Na_2CO_3.10H_2O$	1. –1.5	Monoclinic
1.5	Sal Ammoniac	NH_4Cl	1.5–2.	Cubic
1.6	Carnallite	$MgCl_2.KCl.6H_2O$	1. –2.	Orthorhombic
1.6– 1.8	Ulexite	$NaCaB_5O_9.6H_2O$	1.	Monoclinic
1.7	Struvite	$NH_4MgPO_4.6H_2O$	1.5–2.	Orthorhombic
1.7– 1.8	Borax (Tinkal)	$Na_2B_4O_7.10H_2O$	2. –2.5	Monoclinic
1.7– 1.8	Epsomite	$MgSO_4.7H_2O$	2. –2.5	Orthorhombic
1.8– 1.9	Melanterite (Copperas)	$FeSO_4.7H_2O$	2.	Monoclinic
1.9	Kernite (Rasorite)	$Na_2B_4O_7.4H_2O$	2.5	Monoclinic
1.9	Allophane	$Al_2SiO_5.5H_2O$	3.	Amorphous
1.9– 2.0	Sylvite	KCl	2. –2.5	Cubic
1.9– 2.1	Niter (Saltpeter)	KNO_3	1.5–2.	Orthorhombic
1.9– 2.1	Sulphur	S	1.5–2.5	Orthorhombic
1.9– 2.3	Graphite	C	1. –2.	Hexagonal
2.0– 2.2	Chrysocolla	$H_2CuSiO_4.H_2O$	2. –3.	Amorphous
2.0– 2.2	Kainite	$MgSO_4.KCl.3H_2O$	2.5–3.	Monoclinic
2.1	Copiapite	$Fe_2(Fe.OH)_2(SO_4)_5.18H_2O$	1.5–2.5	Monoclinic
2.1– 2.2	Chabazite	$CaAl_2Si_6O_{16}.8H_2O$	4. –5.	Hexagonal
2.1– 2.2	Heulandite	$H_4CaAl_2(SiO_3)_6.3H_2O$	3. –4.	Monoclinic
2.1– 2.2	Stilbite (Desmine)	$(Ca,Na_2)Al_2Si_6O_{16}.6H_2O$	3. –4.	Monoclinic
2.1– 2.2	Trona	$Na_2CO_3.NaHCO_3.2H_2O$	2.5–3.	Monoclinic

2.1– 2.3	Opal	$SiO_2.nH_2O$	5.5–6.	Amorphous
2.1– 2.3	Soda Niter	$NaNO_3$	1.5–2.	Hexagonal
2.2– 2.3	Analcite	$Na_2Al_2(SiO_3)_4.2H_2O$	5. –5.5	Cubic
2.2– 2.3	Glauconite	$FeKSi_2O_6.H_2O$?	1.5–2.	Monoclinic ?
2.2– 2.3	Natrolite	$Na_2Al(AlO)(SiO_3)_3.2H_2O$	5. –5.5	Orthorhombic
2.2– 2.4	Colemanite	$Ca_2B_6O_{11}.5H_2O$	3.5–4.5	Monoclinic
2.2– 2.4	Gypsum	$CaSO_4.2H_2O$	1.5–2.	Monoclinic
2.2– 2.4	Sodalite	$Na_4Al_2(Al.Cl)(SiO_4)_3$	5. –6.	Cubic
2.2– 2.6	Kaolinite	$H_4Al_2Si_2O_9$	1. –2.5	Monoclinic
2.3	Laumontite	$Ca(Al.2OH)_2(Si_2O_5)_2.2H_2O$	1. –2.	Monoclinic
2.3– 2.4	Apophyllite	$H_{14}K_2Ca_8(SiO_3)_{16}.9H_2O$	4.5–5.	Tetragonal
2.3– 2.4	Brucite	$Mg(OH)_2$	2. –2.5	Hexagonal
2.3– 2.4	Gibbsite	$Al(OH)_3$	2.5–3.	Monoclinic
2.3– 2.4	Thomsonite	$2(Ca,Na_2)Al_2(SiO_4)_2.5H_2O$	5. –5.5	Orthorhombic
2.3– 2.4	Wavellite	$(Al.OH)_3(PO_4)_2.5H_2O$	3.5–4.	Orthorhombic
2.3– 2.8	Garnierite	$H_2(Ni,Mg)SiO_4$	2. –3.	?
2.4	Lapis Lazuli (Lazurite)	Silicate—Na,Ca,Al, etc.	5. –5.5	Cubic
2.4– 2.5	Cancrinite	Silicate—Na,Ca,Al, etc.	5. –6.	Hexagonal
2.4– 2.5	Harmotome	$BaAl_2Si_6O_{16}.6H_2O$	4. –5.	Monoclinic
2.5	Leucite	$KAlSi_2O_6$	5.5–6.	Pseudocubic
2.5– 2.6	Bauxite	$Al_2O(OH)_4$	1. –3.	?
2.5– 2.6	Kieserite	$MgSO_4.H_2O$	3.	Monoclinic
2.5– 2.6	Microcline	$KAlSi_3O_8$	6. –6.5	Triclinic
2.5– 2.6	Orthoclase	$KAlSi_3O_8$	6. –6.5	Monoclinic
2.5– 2.8	Serpentine	$H_4Mg_3Si_2O_9$	3. –4.	Monoclinic
2.6	Albite	$NaAlSi_3O_8$	6. –6.5	Triclinic
2.6	Nephelite (Elaeolite)	$(Na,K)_8Al_8Si_9O_{34}$	5. –6.	Hexagonal
2.6	Quartz	SiO_2	7.	Hexagonal
2.6– 2.7	Cordierite (Iolite)	$(Mg,Fe)_4Al_3(OH)_2(Si_2O_7)_5$	7. –7.5	Orthorhombic
2.6– 2.7	Pharmacolite	$CaHAsO_4.2H_2O$	2. –2.5	Monoclinic
2.6– 2.7	Vivianite	$Fe_3(PO_4)_2.8H_2O$	1.5–2.	Monoclinic
2.6– 2.7	Zaratite	$NiCO_3.2Ni(OH)_2.4H_2O$	3.	?
2.6– 2.8	Alunite	$K_2(Al.2OH)_6(SO_4)_4$	3.5–4.	Hexagonal
2.6– 2.8	Beryl	$Be_3Al_2(SiO_3)_6$	7.5–8.	Hexagonal

TABLE OF MINERALS ARRANGED ACCORDING TO INCREASING SPECIFIC GRAVITY,—WITH CHEMICAL COMPOSITION AND OTHER PHYSICAL PROPERTIES

Specific Gravity	Mineral	Composition	Hardness	Crystallization
2.6– 2.8	Scapolite (Wernerite)	Silicate—Na,Ca,Al, etc.	5. –6.	Tetragonal
2.6– 2.8	Talc	$H_2Mg_3Si_4O_{12}$	1. –2.5	Monoclinic
2.6– 2.8	Turquois	$H_5[Al(OH)_2]_6Cu(OH)(PO_4)_4$	6.	Triclinic
2.6– 3.	Chlorite	$H_8Mg_5Al_2Si_3O_{18}$?	1. –2.5	Monoclinic
2.7	Calcite	$CaCO_3$	3.	Hexagonal
2.7	Labradorite	Silicate—Na,Ca,Al, etc.	6. –6.5	Triclinic
2.7	Oligocalse	Silicate—Na,Ca,Al, etc.	6. –6.5	Triclinic
2.7– 2.8	Anorthite	$CaAl_2Si_2O_8$	6.– 6.5	Triclinic
2.7– 2.8	Glauberite	$Na_2SO_4.CaSO_4$	2.5	Monoclinic
2.7– 2.8	Pectolite	$(Ca,Na_2)_2(SiO_3)_2$	4. -5.	Monoclinic
2.7– 2.8	Polyhalite	$K_2MgCa_2(SO_4)_4.2H_2O$	3. –3.5	Monoclinic
2.7– 3.2	Biotite	Silicate—Mg,Fe, etc.	2.5–3.	Monoclinic
2.8– 2.9	Lepidolite	Silicate–Li,Al, etc.	2. –3.	Monoclinic
2.8– 2.9	Paragonite	$H_2NaAl_3(SiO_4)_3$	2. –3.	Monoclinic
2.8– 2.9	Pyrophyllite	$H_2Al_2Si_4O_{12}$	1. –2.	Orthorhombic
2.8– 2.9	Wollastonite	$CaSiO_3$	4.5–5.	Monoclinic
2.8– 3.	Anhydrite	$CaSO_4$	3. –3.5	Orthorhombic
2.8– 3.	Phlogopite	Silicate—K,Mg,Al, etc.	2.5–3.	Monoclinic
2.8– 3.	Prehnite	$H_2Ca_2Al_2(SiO_4)_3$	6. –7.	Orthorhombic
2.8– 3.1	Muscovite	Silicate—K,Al, etc.	2. –3.	Monoclinic
2.9	Dolomite	$CaMg(CO_3)_2$	3.5–4.	Hexagonal
2.9– 3.	Aragonite	$CaCO_3$	3.5–4.	Orthorhombic
2.9– 3.	Boracite	$Mg_7Cl_2B_{16}O_{30}$	7.	Pseudocubic
2.9– 3.	Cryolite	Na_3AlF_6	2.5–3.	Monoclinic
2.9– 3.	Danburite	$CaB_2(SiO_4)_2$	7. –7.5	Orthorhombic
2.9– 3.	Datolite	$Ca(B.OH)SiO_4$	5. –5.5	Monoclinic
2.9– 3.1	Magnesite	$MgCO_3$	3.5–5.	Hexagonal
2.9– 3.1	Tremolite	$H_2Ca_2Mg_5$	5. –6.	Monoclinic

3.	Phenacite	Be_2SiO_4	7. -8.	Hexagonal
3.	Erythrite	$Co_3(AsO_4)_2.8H_2O$	1.5–2.5	Monoclinic
3.	Margarite	$H_2CaAl_4Si_2O_{12}$	3. –4.5	Monoclinic
3. – 3.1	Amblygonite	$Li(AlF)PO_4$	6.	Triclinic
3. – 3.1	Annabergite	$Ni_3(AsO_4)_2.8H_2O$	1. –2.5	Monoclinic
3. – 3.1	Glaucophane	Silicate—Ca,Mg,Fe,Al,Na, etc.	6. –6.5	Monoclinic
3. – 3.1	Lazulite	$Mg(Al.OH)_2(PO_4)_2$	5. –5.5	Monoclinic
3. – 3.2	Fluorite	CaF_2	4.	Cubic
3. – 4.	Allanite (Orthite)	Silicate—Ca,Al,Ce,Fe, etc.	5.5–6.	Monoclinic
3. – 4.3	Wad	MnO_2,H_2O, etc.	1. –3.	Amorphous
3.1	Lawsonite	$Ca(Al.OH)_2(SiO_3)_2$	7.5–8.	Orthorhombic
3.1– 3.2	Andalusite	Al_2SiO_5	6. –7.5	Orthorhombic
3.1– 3.2	Anthophyllite	$(Mg,Fe)_4(SiO_3)_4$	5. –6.	Orthorhombic
3.1– 3.2	Apatite	$Ca_5F(PO_4)_3$	5.	Hexagonal
3.1– 3.2	Spodumene	$LiAl(SiO_3)_2$	7.–7.5	Monoclinic
3.1– 3.3	Chondrodite	Silicate—Mg,F, etc.	6. –6.5	Monoclinic
3.1– 3.3	Enstatite	$Mg_2(SiO_3)_2$	5. –6.	Orthorhombic
3.1– 3.3	Scorodite	$FeAsO_4.2H_2O$	3.5–4.	Orthorhombic
3.1– 3.5	Diamond	C	10.	Cubic
3.2	Chlorastrolite	Silicate—Ca,Al, etc.	5. –6.	?
3.2– 3.3	Diopside	$CaMg(SiO_3)_2$	5. –6.	Monoclinic
3.2– 3.3	Sillimanite (Fibrolite)	Al_2SiO_5	6. –7.	Orthorhombic
3.2– 3.5	Bronzite	$(Mg,Fe)_2(SiO_3)_2$	5. –6.	Orthorhombic
3.2– 3.6	Augite	Silicate—Ca,Mg,Fe,Al, etc.	5. –6.	Monoclinic
3.2– 3.6	Olivine (Chrysolite, Peridot)	$(Mg,Fe)_2SiO_4$	6.5–7.	Orthorhombic
3.3	Axinite	Silicate–B,Ca,Fe, etc.	6. –7.	Triclinic
3.3	Dioptase	H_2CuSiO_4	5.	Hexagonal
3.3	Dumortierite	$HBAl_8Si_3O_{20}$	7.	Orthorhombic
3.3	Piedmontite	Silicate–Ca,Mn,Al, etc.	6.5	Monoclinic
3.3– 3.4	Zoisite	$Ca_2Al_2(Al.OH)(SiO_4)_3$	6. –6.5	Orthorhombic
3.3– 3.5	Diaspore	AlO.OH	6. –7.	Orthorhombic
3.3– 3.5	Epidote	Silicate–Ca,Al,Fe, etc.	6. –7.	Monoclinic
3.3– 3.5	Hemimorphite	$H_2Zn_2SiO_5$	4.5–5.	Orthorhombic
3.3– 3.5	Hypersthene	$(Fe,Mg)_2(SiO_3)_2$	5. –6.	Orthorhombic

TABLE OF MINERALS ARRANGED ACCORDING TO INCREASING SPECIFIC GRAVITY,—WITH CHEMICAL COMPOSITION AND OTHER PHYSICAL PROPERTIES

Specific Gravity	Mineral	Composition	Hardness	Crystallization
3.3– 3.5	Vesuvianite	Silicate—Ca,Al,F, etc.	6.5	Tetragonal
3.4– 3.5	Orpiment	As_2S_3	1.5–2.	Monoclinic
3.4– 3.6	Chloritoid	$H_2FeAl_2SiO_7$	6. –7.	Monoclinic
3.4– 3.6	Realgar	AsS	1.5–2.	Monoclinic
3.4– 3.6	Titanite	$CaTiSiO_5$	5. –5.5	Monoclinic
3.4– 3.6	Topaz	$Al_2(F,OH)_2SiO_4$	8.	Orthorhombic
3.4– 3.7	Rhodonite	$MnSiO_3$	5. –6.	Triclinic
3.4– 3.8	Staurolite	Silicate—Fe,Al, etc.	7. –7.5	Orthorhombic
3.5	Aegirite (Acmite)	$NaFe(SiO_3)_2$	6. –6.5	Monoclinic
3.5– 3.6	Rhodochrosite	$MnCO_3$	3.5–4.5	Hexagonal
3.5– 3.7	Cyanite (Disthene)	Al_2SiO_5	4. –7.	Triclinic
3.6– 3.8	Chrysoberyl	$Be(AlO_2)_2$	8.5	Orthorhombic
3.6– 3.8	Strontianite	$SrCO_3$	3.5–4.	Orthorhombic
3.6– 4.	Limonite	$Fe_2O_3.nH_2O$	1. –5.5	?
3.6– 4.4	Spinel	Aluminate—Mg,Fe,Cr, etc.	7.5–8.	Cubic
3.7– 3.8	Atacamite	$Cu(OH)Cl.Cu(OH)_2$	3. –3.5	Orthorhombic
3.7– 3.8	Azurite	$2CuCO_3.Cu(OH)_2$	3.5–4.	Monoclinic
3.7– 3.9	Siderite	$FeCO_3$	3.5–4.	Hexagonal
3.7– 4.1	Malachite	$CuCO_3.Cu(OH)_2$	3.5–4.	Monoclinic
3.7– 4.7	Psilomelane	MnO_2, mainly	5. –6.	Amorphous ?
3.8– 3.9	Anatase (Octahedrite)	TiO_2	5.5–6.	Tetragonal
3.8– 3.9	Brochantite	$CuSO_4.3Cu(OH)_2$	3.5	Orthorhombic
3.8– 4.1	Brookite	TiO_2	5.5– 6.	Orthorhombic
3.8– 4.2	Garnet	Silicate—Ca,Mg,Mn,Al,Fe, etc.	6. –7.	Cubic
3.9– 4.	Alabandite	MnS	3.5	Cubic
3.9– 4.	Celestite	$SrSO_4$	3. –3.5	Orthorhombic
3.9– 4.1	Corundum	Al_2O_3	9.	Hexagonal
3.9– 4.1	Ilvaite	$CaFe_2(Fe.OH)(SiO_4)_2$	5.5–6.	Orthorhombic

4. – 4.4	Goethite	FeO.OH	4.5–5.5	Orthorhombic
4.1– 4.3	Chalcopyrite	$CuFeS_2$	3.5–4.	Tetragonal
4.1– 4.5	Smithsonite	$ZnCO_3$	5.	Hexagonal
4.1– 4.6	Olivenite	$Cu(Cu.OH)AsO_4$	3.	Orthorhombic
4.2– 4.3	Rutile	TiO_2	6. –7.	Tetragonal
4.2– 4.3	Witherite	$BaCO_3$	3.5–4.	Orthorhombic
4.2– 4.4	Manganite	MnO.OH	3.5–4.	Orthorhombic
4.3– 4.5	Stannite	Cu_2FeSnS_4	4.	Tetragonal
4.3– 4.6	Chromite	$(Fe,Cr)[(Cr,Fe)O_2]_2$	5.5	Cubic
4.3– 4.7	Barite	$BaSO_4$	2.5–3.5	Orthorhombic
4.3– 5.4	Tetrahedrite	$Cu_8Sb_2S_7$	3. –4.	Cubic
4.3– 5.5	Ilmenite	$FeTiO_3$	5. –6.	Hexagonal
4.4	Enargite	Cu_3AsS_4	3.	Orthorhombic
4.4– 4.6	Xenotime	YPO_4	4. –5.	Tetragonal
4.4– 4.8	Zircon	$ZrSiO_4$	7.5	Tetragonal
4.4– 5.4	Thorite (Orangite)	$ThSiO_4$	4.5–5.	Tetragonal
4.5	Gadolinite	$Fe[Be(Y.O)SiO_4]_2$	6. –7.	Monoclinic
4.5– 4.6	Pyrrhotite	FeS	3.5–4.5	Hexagonal
4.6	Covellite	CuS	1.5–2.	Hexagonal
4.6– 4.7	Stibnite	Sb_2S_3	2.–2.5	Orthorhombic
4.6– 4.8	Marcasite	FeS_2	6. –6.5	Orthorhombic
4.6– 5.1	Pentlandite	(Fe,Ni)S	3.5–4.	Cubic
4.7– 4.8	Hausmannite	Mn_2MnO_4	5. –5.5	Tetragonal
4.7– 4.8	Molybdenite	MoS_2	1. –1.5	Hexagonal
4.7– 4.8	Pyrolusite	MnO_2	1. –2.5	Orthorhombic ?
4.7– 4.9	Braunite	$MnMnO_3$	6. –6.5	Tetragonal
4.8– 5.8	Linnaeite	$(Ni,Co)_3S_4$	5.5	Cubic
4.8– 9.7	Uraninite (Pitchblende)	UO_3,UO_2,PbO, etc.	3. –3.5	Cubic
4.9– 5.	Greenockite	CdS	3. –3.5	Hexagonal
4.9– 5.2	Bornite	Cu_5FeS_4	3. –3.5	Cubic
4.9– 5.2	Magnetite	$Fe(FeO_2)_2$	5.5–6.5	Cubic
4.9– 5.2	Pyrite	FeS_2	6.– 6.5	Cubic
4.9– 5.3	Hematite	Fe_2O_3	2. –6.5	Hexagonal
4.9– 5.3	Monazite	$(Ce,La,Di)PO_4$	5. –5.5	Monoclinic

TABLE OF MINERALS ARRANGED ACCORDING TO INCREASING SPECIFIC GRAVITY,—WITH CHEMICAL COMPOSITION AND OTHER PHYSICAL PROPERTIES

Specific Gravity	Mineral	Composition	Hardness	Crystallization
5. – 5.2	Franklinite	$(Fe,Mn,Zn)(FeO_2)_2$	5.5–6.	Cubic
5.2– 5.3	Senarmontite	Sb_2O_3	2. –2.5	Cubic
5.3– 5.9	Millerite	NiS	3. –3.5	Hexagonal
5.4– 5.7	Zincite	ZnO	4. –4.5	Hexagonal
5.4– 6.4	Columbite	$(Fe,Mn)[(Nb,Ta)O_3]_2$	6. –6.5	Orthorhombic
5.5– 5.6	Cerargyrite	AgCl	1. –1.5	Cubic
5.5– 5.6	Proustite	Ag_3AsS_3	2.5	Hexagonal
5.5– 5.8	Chalcocite	Cu_2S	2.5–3.	Orthorhombic
5.5– 5.8	Jamesonite	$Pb_2Sb_2S_5$	2. –2.5	Orthorhombic
5.6– 5.8	Arsenic	As	3. –4.	Hexagonal
5.6– 5.8	Samarskite	Niobate—Y,Ce,U,Fe, etc.	5. –6.	Orthorhombic
5.7– 5.9	Bournonite	$PbCuSbS_3$	2.5–3.	Orthorhombic
5.7– 6.1	Cuprite	Cu_2O	3.5–4.	Cubic
5.8	Pyrargyrite	Ag_3SbS_3	2.5–3.	Hexagonal
5.8– 5.9	Fergusonite	$Y(Nb,Ta)O_4$	5.5–6.	Tetragonal
5.9– 6.1	Crocoite	$PbCrO_4$	2.5	Monoclinic
5.8– 6.2	Melaconite (Tenorite)	CuO	1. –3.	Monoclinic
5.9– 6.2	Arsenopyrite	FeAsS	5.5–6.	Orthorhombic
5.9– 6.2	Scheelite	$CaWO_4$	4.5	Tetragonal
6. – 6.2	Polybasite	$(Ag,Cu)_9SbS_6$	2. –2.5	Monoclinic
6. – 6.4	Cobaltite	CoAsS	5.5	Cubic
6.1– 6.4	Anglesite	$PbSO_4$	3. –3.5	Orthorhombic
6.2– 6.3	Stephanite	Ag_5SbS_4	2. –2.5	Orthorhombic
6.2– 6.3	Stromeyerite	$(Cu,Ag)_2S$	2.5–3.	Orthorhombic
6.2– 6.4	Leadhillite	$PbSO_4.2PbCO_3.Pb(OH)_2$	2.5	Monoclinic
6.3– 7.	Wulfenite	$PbMoO_4$	3.	Tetragonal
6.4– 6.5	Calomel	HgCl	1. –2.	Tetragonal
6.4– 6.6	Bismuthinite	Bi_2S_3	2	Orthorhombic

6.5– 7.1	Pyromorphite	$Pb_5Cl(PO_4)_3$	3.5–4.	Hexagonal
6.6– 6.7	Antimony	Sb	3. –4.	Hexagonal
6.7– 7.2	Vanadinite	$Pb_5Cl(VO_4)_3$	3.	Hexagonal
6.7– 7.3	Huebnerite	$MnWO_4$	5. –5.5	Monoclinic
6.8– 7.	Cassiterite	SnO_2	6. –7.	Tetragonal
7. – 7.3	Mimetite	$Pb_5Cl(AsO_4)_3$	3.5–4.	Hexagonal
7.1– 7.4	Löllingite	$FeAs_2$	5. –5.5	Orthorhombic
7.1– 7.5	Wolframite	$(Fe,Mn)WO_4$	5. –5.5	Monoclinic
7.2– 7.4	Argentite	Ag_2S	2. –2.5	Pseudocubic
7.2– 7.5	Domeykite	Cu_3As	3.5	?
7.3– 7.6	Galena	PbS	2.5	Cubic
7.3– 7.7	Niccolite	NiAs	5.5	Hexagonal
7.3– 7.8	Iron	Fe	4.5–6.	Cubic
7.5	Ferberite	$FeWO_4$	5. –5.5	Monoclinic
7.9– 8.3	Sylvanite	$(Au,Ag)Te_2$	1.5–2.	Monoclinic
8. – 8.2	Cinnabar	HgS	2. –2.5	Hexagonal
8.5– 9.	Copper	Cu	2.5–3.	Cubic
9.	Calaverite	$AuTe_2$	2.5	Monoclinic
9.4–10.	Dyscrasite	Ag_3Sb	3.5	Orthorhombic
9.7– 9.8	Bismuth	Bi	2. –2.5	Hexagonal
10. –12.	Silver	Ag	2.5–3.	Cubic
13.5–13.6	Mercury	Hg	.....	Amorphous
13.7–14.1	Amalgam	(Ag,Hg)	3. –3.5	Cubic
14. –19.	Platinum	Pt	4. –5.	Cubic
15.6–19.3	Gold	Au	2.5–3.	Cubic
20. –21.2	Iridosmium	(Os,Ir)	6. –7.	Hexagonal

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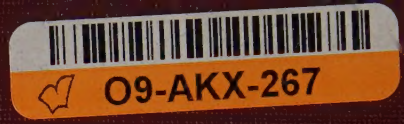
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